



**NEW MEXICO**  
**ENVIRONMENT DEPARTMENT**  
**Construction Programs Bureau**

***Recommended Standards for  
Wastewater Facilities***

POLICIES FOR THE DESIGN, REVIEW, AND  
APPROVAL OF PLANS AND SPECIFICATIONS  
FOR WASTEWATER COLLECTION AND  
TREATMENT FACILITIES

***2003 Edition***



# Recommended Standards for Wastewater Facilities

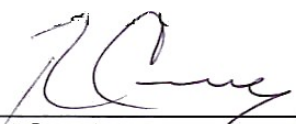
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2003 Edition

"The guidelines set forth in this document, Recommended Standards for Wastewater Facilities, are intended solely for the guidance of employees of the New Mexico Environment Department (NMED). They are not intended to, nor do they, constitute regulations promulgated by NMED, the New Mexico Environmental Improvement Board, or the New Mexico Water Quality Control Commission, and are not enforceable as such. They may not be relied upon to create a right or benefit, substantive or procedural, enforceable at law or in equity, by any person.

The guidelines set forth in this document have been developed to assist NMED in consistently reviewing plans and specifications submitted for wastewater system improvements and construction. They incorporate nationally recognized guidelines for engineering practices in furtherance of public health and environmental protection as modified by NMED to address New Mexico practices and particulars. They do not contain criteria required by NMED for approval of plans and specifications, and are not intended to supersede any grant or loan requirements or any policy, requirement, or regulation concerning wastewater system improvements or construction. NMED will review all plans and specifications objectively and with professional judgment to establish whether they conform to applicable laws, regulations, and engineering requirements and practices. NMED encourages the development and implementation of new processes and equipment, and will favorably consider them with the appropriate demonstration of successful applications.

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\_\_\_\_\_  
Ron Curry, Cabinet Secretary

10/1/03  
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Date

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## CHAPTER 10

### PRELIMINARY ENGINEERING REPORTS AND FACILITY PLANS

#### 10. GENERAL

##### 10.1 ENGINEERING SERVICES

Engineering services are performed in three steps:

- a. Engineering Report or Facility Plan hereinafter referred to as a Preliminary Engineering Report (PER);
- b. Preparation of construction specifications and contractual documents; and
- c. Construction compliance, inspection, administration, and acceptance.

Chapter 10, Engineering Reports and Facility Plans, covers only item a. above.

##### 10.2 PRELIMINARY PROJECT SUBMITTAL

A preliminary project submittal may be necessary prior to preparation of a PER. This submittal will include:

- a. A description of problems or developments that have resulted in consideration of a wastewater facilities project;
- b. Identification of governmental and consultant representatives authorized to provide information and seek regulatory agency approvals and decisions regarding the project; and
- c. Identification of potential treated wastewater discharge and/or reuse locations for the purpose of regulatory agency determinations of suitable effluent quality requirements.

No approval for construction can be issued until final, signed and sealed detailed plans and specifications have been submitted and approved by the appropriate reviewing authority. Refer to Chapter 20.



## **11. PRELIMINARY ENGINEERING REPORT OR FACILITY PLAN CONCEPT**

The Preliminary Engineering Report (PER) identifies and evaluates wastewater related problems; assembles basic information; presents criteria and assumptions for the basis of design; examines alternate projects with preliminary layouts and cost estimates; describes financing methods, sets forth anticipated charges for users; reviews organizational and staffing requirements; offers a conclusion with a proposed project for client consideration; and outlines official actions and procedures to implement the project. The planning document will include sufficient detail to demonstrate that the proposed project meets applicable criteria and provide sufficient information for the decision maker to determine a reasonable course of action.

The concept (including process description and sizing), factual data, and controlling assumptions and considerations for the functional planning of wastewater facilities are presented for each process unit and for the whole system. These data form the continuing technical basis for the detailed design and preparation of construction plans and specifications.

Architectural, structural, mechanical, and electrical designs are usually excluded. Sketches may be desirable to aid in presentation of a project. Outline specifications of process units, special equipment, etc., are occasionally included.

PERs may be completed for minor collection system, pump station, and interceptor projects, but will be completed for projects involving new, expanded, upgraded, or rehabilitated wastewater treatment facilities and major collection, interceptor sewer, and pump station projects. The determination of classification as major or minor collection interceptor sewer and pump station projects will be made by the reviewing authority based on review of recommended classification by the owner.

For federal or state financial grant or loan projects, additional requirements may apply.

## **12. PRELIMINARY ENGINEERING REPORT FORMAT AND CONTENT**

The primary funding agencies for wastewater projects in New Mexico have agreed to a common format for PERs based on guidance provided by the USDA Rural Utility Service (RUS) Bulletin 1780 series. The bulletin for wastewater is 1780-3 and can be obtained from the RUS website at [www.usda.gov/rus/water/regs-bulletins.htm](http://www.usda.gov/rus/water/regs-bulletins.htm). PERs will be signed and sealed by the responsible professional engineer and contain the following and other pertinent information as required by the reviewing authority:



## **12.1 OVERVIEW – PROBLEM DEFINED**

Describe the proposed project, background, and problems needing correction. Summarize the existing and previous local and regional wastewater facility and related planning documents.

## **12.2 PROJECT PLANNING AREA**

### **12.2.1 Location and Service Area**

Describe the planning area and existing and potential future service areas. State the planning period being considered. Project site information will include legal and natural boundaries, topography, soils, geologic conditions, depth to bedrock, groundwater level, floodway or floodplain considerations, and other pertinent site information.

### **12.2.2 Environmental Resources Present**

Consideration will be given to minimizing any potential adverse environmental effects of the proposed project. If appropriate, compliance with planning requirements of federal, state, and local regulatory agencies will be documented. Information will be provided regarding the location and significance of important land resources such as prime farmland, wetlands, floodplains, historic and cultural sites, and endangered species that will be considered in project planning.

### **12.2.3 Growth Areas and Population Trends**

Present and predicted population will be based on a minimum 20-year planning period. Phased construction of wastewater facilities will be considered in rapid growth areas. Sewers and other facilities with a design life in excess of 20 years will be designed for the extended period. Projections will be reasonable and based upon historical record or other justifiable sources.

## **12.3 EXISTING FACILITIES**

### **12.3.1 Location Map**

Drawings identifying the site of the project and anticipated location and alignment of proposed facilities are required.





### **12.3.2 History**

Provide information regarding the history of the existing facility.

### **12.3.3 Condition of Facilities**

Provide a description of the existing facilities system including present condition, suitability for continued use, and evaluation of problems needing correction. The impact of the proposed project on all existing wastewater facilities, including gravity sewers, lift stations, and treatment facilities will be evaluated. Describe current and future compliance with applicable permits, such as EPA NPDES and NMED Ground Water Discharge Permits.

### **12.3.4 Financial Status of any Operating Central Facilities**

Provide information regarding rate schedules, annual operation and maintenance (O&M) cost, number of connections, tabulation of users by monthly usage categories, and revenue received for the last three fiscal years. Describe existing debt and required reserve accounts.

## **12.4 NEED FOR PROJECT**

### **12.4.1 Health and Safety**

Describe concerns, noting any correspondence or communications from or to regulatory agencies regarding compliance issues. The New Mexico Environment Department (NMED) Ground Water Quality and Surface Water Quality Bureaus will be contacted for their assessment of the proposed project and any relevant regulations or permit conditions.

### **12.4.2 System Operation and Maintenance**

Describe O&M concerns that necessitate and/or affect the proposed project, indicating those of greatest impact. Before proposing additional capacity, indicate whether infiltration/inflow, inefficient designs, and other operational or managerial problems have been investigated and addressed.



### **12.4.3 Growth**

Provide information and justification regarding allowances for reasonable growth over the construction and planning periods, including phased projects as appropriate. Confirm the number of new customers committed to the project and the revenue stream necessary to support O&M.

### **12.4.4 Other Considerations**

Discuss other considerations for the proposed project; such as wastewater reuse, flat or hilly topography, pending changes in effluent permit limits, biosolids management, and redundancy.

## **12.5 ALTERNATIVES CONSIDERED**

This section will contain a description of the reasonable alternatives that were considered in planning a solution to meet the identified need (s). The process of selection of wastewater treatment alternatives for detailed evaluation will be discussed. All wastewater management alternatives considered, including no action, and the basis for the engineering judgment for selection of the alternatives chosen for detailed evaluation, will be included. The description will include the following information for each alternative:

### **12.5.1 Design Criteria**

Discuss and summarize the design parameters or basis of design that will be used to compare the alternatives considered. These will include permit limits, best engineering practice, and applicable regulations such as New Mexico Water Quality Regulations, Federal Americans with Disabilities Act, Standards for the Use or Disposal of Sewage Sludge (40 CFR 503), etc.

### **12.5.2 Description**

A written description of all reasonable proposed alternatives is required. The alternatives will include feasible treatment technologies and associated collection facilities. A feasible alternative may be a combination of central treatment and collection facilities and management of onsite facilities, or only the latter. The following will be considered in developing the alternatives:

- a. *Sewer system revisions.*  
Proposed revisions to the existing sewer system including adequacy of portions not being changed by the project.



*b. Wet weather flows.*

Facilities to transport and treat wet weather flows in a manner that complies with federal, state and local regulations will be provided.

*c. Site evaluation.*

When a site will be used which is critical with respect to the following items, appropriate measures will be taken to minimize adverse impacts:

1. Compatibility of the treatment process with the present and planned future land use, including noise, potential odors, air quality, and anticipated biosolids processing and disposal techniques, will be considered. Non-aerated lagoons will not be used if excessive sulfate is present in the wastewater that could be suspected to cause odor problems. Wastewater treatment facilities will be separate from habitation or any area likely to be built up within a reasonable future period and will be separated in accordance with state and local requirements.
2. Zoning and other land use restrictions will be identified.
3. An evaluation of the accessibility and topography of the site will be submitted.
4. Area for future plant expansion will be identified.
5. Direction of prevailing wind will be identified.
6. Flood considerations, including the 25 and 100-year flood levels, impact on floodplain and floodway, and compliance with applicable regulations regarding construction in flood prone areas, will be evaluated. Chapter 50, paragraph 51.2 contains requirements for protection from flooding.
7. Geologic information, depth to bedrock, karst features, or other geologic considerations of significance to the project will be included. Lagoons will not be located in karst areas unless the specific geologic and construction details are acceptable.
8. Protection of groundwater including public and private wells is of utmost importance. Demonstration that protection will be provided will be included. The regulatory agency will be contacted for required separation.
9. Soil type and suitability for construction and depth to normal and seasonal high groundwater will be determined.
10. The location, depth, and discharge point of any field tile in the immediate area of the proposed site will be identified.



11. Present and known future effluent quality requirements determined by the regulatory agency will be included.
  12. Access to receiving stream for the outfall line will be discussed and displayed.
  13. A preliminary assessment of site availability will be included.
- d. *Unit sizing.*  
Unit operation and unit process sizing and basis will be provided.
- e. *Flow diagram.*  
Flow diagram of treatment facilities including all recycle flows.
- f. *Emergency operation.*  
Emergency operation requirements as outlined in Chapter 40, Section 46 and Chapter 50, paragraph 56.1 will be provided. State or local regulatory agencies may have more stringent requirements.
- g. *Technology not included in these standards.*  
Chapter 50, paragraph 53.2 outlines procedures for introducing and obtaining approval to use technology not included in these standards. Proposals to use technology not included in these standards will address the requirements of paragraph 53.2.
- h. *Biosolids.*  
The solids disposal options considered and method selected will be included. This is critical to completion of a successful project. Compliance with requirements of Chapter 80, Biosolids Processing, Storage, and Disposal will be assured.
- i. *Treatment during construction.*  
A plan for the method and level of treatment to be achieved during construction will be developed and included in the facility plan that will be submitted to the regulatory agency for review and approval. This approved treatment plan will be implemented by inclusion in the plans and specifications to be bid for the project. Refer to paragraph 20.1.5 and Section 21 of Chapter 20.



### **12.5.3 Map**

A schematic layout or process flow diagram will be provided.

### **12.5.4 Environmental Impacts**

Describe unique direct and indirect impacts on floodplains, wetlands, endangered species, cultural resources, etc. as they relate to a specific alternative. Other documents, such as an Environmental Information Document (EID), may be referenced for a more detailed discussion.

### **12.5.5 Land Requirements**

Describe land that will be required for the proposed alternatives and how it will be acquired (purchase, lease, easement, etc.). Note any difficulties that may be encountered in acquisition, such as the necessity to prepare an Environmental Impact Statement (EIS) to access Federal lands.

### **12.5.6 Construction Problems**

Discuss potential problems for construction, such as subsurface rock, karst terrain, high water table, or limited access. Note that if more than one acre of land will be disturbed, a Storm Water Pollution Prevention Permit (SWPPP) will be required.

### **12.5.7 Cost Estimates**

Cost estimates will present an equivalent comparison between alternatives. The estimates will be summarized in the report in a comparative table and a detailed line item estimate will be included as an appendix. The estimates will include the following:

#### **12.5.7.1 Construction Costs**

Capital costs for all items necessary for a fully functional facility.

#### **12.5.7.2 Non-Construction Costs**

Costs for other necessary items, such as mitigation measures, engineering, legal, right-of-way, and permits (both construction and operational).



### **12.5.7.3      *Annual Operation and Maintenance***

Include annual costs for operation and maintenance of the proposed facility. A life cycle cost analysis will be presented for extended planning periods or projects with significant replacement expenses for short-lived items, such as pumps.

### **12.5.7.4      *Present Worth***

A present worth analysis will be presented for all project costs based on terms of the likely funding source, such as the Clean Water State Revolving Fund (CWSRF) loan program with a base interest rate of 3%

and a term of 20 years. The calculations will assume no grant funding. The results will be reduced to a monthly cost per household and presented in a summary table for ease of reference.

### **12.5.8    *Advantages/Disadvantages***

Discuss the ability of each alternative to meet the design criteria and the owner's needs within financial and operational constraints. Include other relevant items, such as regulatory requirements, compatibility with existing comprehensive area-wide development plans, public concerns, and health and environmental issues. A matrix rating system can be useful in displaying the information.

## **12.6    PROPOSED PROJECT**

This section will contain a fully developed description of the proposed project based on the preliminary description under the evaluation of alternatives. The reasons for selection of the proposed alternative, location of proposed lift station sites, feasibility, and how the project fits into a long-term plan, will be discussed. At least the following information will be included:

### **12.6.1    *Project Design***

#### **12.6.1.1      *Treatment***

Describe the process in detail and identify location of the treatment plant and site of any discharges. Include flow diagrams as necessary.



### **12.6.1.2      *Pumping Stations***

Identify size, type, location and any special power requirements, including backup power.

### **12.6.1.3      *Collection System Layout***

Identify general location of sewer improvements including lengths, sizes, and key components.

### **12.6.1.4      *Hydraulic Calculations***

Calculations will be presented in tabular format and in sufficient detail to determine compliance with generally accepted engineering practice and applicable regulations. The following flows for the design year will be identified and used as a basis for design for sewers, lift stations, wastewater treatment plants, treatment units, and other wastewater handling facilities. Where any of the terms defined in this Section are used in these design standards, the definition contained in this Section applies.

The anticipated design average and design peak flows and waste load for the existing and ultimate conditions will be established. The basis of the projection of initial and future flows and waste load will be included and will reflect the existing, or initial service area, and the anticipated future service area. Flow and organic load information and data needed for new facilities are included in paragraphs 12.6.1.4.3 and 12.6.1.5.6.

#### **12.6.1.4.1      *Flow Definitions and Identification***

##### **a.      *Design average flow.***

The design average flow is the average of the daily volumes to be received for a continuous 12-month period expressed as a volume per unit time. However, the design average flow for facilities having critical seasonal high hydraulic loading periods (e.g., recreational areas, campuses, industrial facilities) will be based on the daily average flow during the seasonal period.



- b. *Design maximum daily flow.*  
The design maximum daily flow is the largest volume of flow to be received during a continuous 24-hour period expressed as a volume per unit time.
- c. *Design peak hourly flow.*  
The design peak hourly flow is the largest volume of flow to be received during a one-hour period expressed as a volume per unit time.
- d. *Design peak instantaneous flow.*  
The design peak instantaneous flow is the instantaneous maximum flow rate to be received.

#### **12.6.1.4.2 Hydraulic Capacity for Wastewater Facilities to serve Existing Collection Systems**

- a. Projections will be made from actual flow data to the extent possible.
- b. The probable degree of accuracy of data and projections will be evaluated. This reliability estimation will include an evaluation of the accuracy of existing data, as well as evaluation of the reliability of estimates of flow reduction anticipated due to infiltration/inflow (I/I) reduction or flow increases due to elimination of sewer bypasses and backups.
- c. Critical data and methodology used will be included. It is recommended that graphical displays of critical peak wet weather flow data (refer to paragraphs 12.6.1.4.1 (b)(c) and (d) in this chapter) be included for a sustained wet weather flow period of significance to the project.

#### **12.6.1.4.3 Hydraulic Capacity for Wastewater Facilities to serve New Collection Systems**

- a. The sizing of wastewater facilities receiving flows from new wastewater collection systems will be based on an average daily flow of 100 gallons





- (0.38 in<sup>3</sup>) per capita plus wastewater flow from industrial plants and major institutional and commercial facilities unless water use data or other justification upon which to better flow estimate is provided.
- b. The 100 gallons per capita per day (gpcd) flow estimate will be used which, in conjunction with a peaking factor, is intended to cover normal infiltration for systems built with modern construction techniques. Refer to Chapter 30 Section 31. However, an additional allowance can be made where conditions are unfavorable, such as a high ground water table.
  - c. If the new collection system is to serve existing development the likelihood of I/I contributions from existing service lines and non-wastewater connections to those service lines will be evaluated and wastewater facilities designed accordingly.

#### **12.6.1.4 Organic Capacity**

The following organic loads for the design year will be identified and used as a basis for design of wastewater treatment facilities, Where any of the terms defined in this Section are used in these design standards, the definition contained in this Section applies.

##### **12.6.1.5.1 Biochemical Oxygen Demand Defined**

The 5-day Biochemical Oxygen Demand (BOD<sub>5</sub>) is defined as the amount of oxygen required to stabilize biodegradable organic matter under aerobic conditions within a five-day period in accordance with Standard Methods for the Examination of Water and Wastewater. Total 5-day Biochemical Oxygen Demand (TBOD<sub>5</sub>) is equivalent to BOD<sub>5</sub> and is sometimes used in order to differentiate carbonaceous plus nitrogenous oxygen demand from strictly carbonaceous oxygen demand.

The carbonaceous 5-day Biochemical Oxygen Demand (CBOD<sub>5</sub>) is defined as BOD<sub>5</sub> less the nitrogenous oxygen demand of the wastewater. See Standard Methods for the Examination of Water and Wastewater.



#### **12.6.1.5.2 Design Average BOD<sub>5</sub>**

The design average BOD<sub>5</sub> is generally the average of the organic load received for a continuous 12-month period for the design year expressed as weight per day. However, the design average BOD<sub>5</sub> for facilities having critical seasonal high loading periods (e.g., recreational areas, campuses, industrial facilities) will be based on the daily average BOD<sub>5</sub> during the seasonal period.

#### **12.6.1.5.3 Design Maximum Day BOD<sub>5</sub>**

The design maximum day BOD<sub>5</sub> is the largest amount of organic load to be received during a continuous 24-hour period expressed as weight per day.

#### **12.6.1.5.4 Design Peak Hourly BOD<sub>5</sub>**

The design peak hourly BOD<sub>5</sub> is the largest amount of organic load to be received during a one-hour period expressed as weight per day.

#### **12.6.1.5.5 Design of Organic Capacity of Wastewater Treatment Facilities to Serve Existing Collection Systems**

- a. Projections will be made from actual waste load data to the extent possible.
- b. Projections will be compared to paragraph 12.6.1.5.6 and an accounting made for significant variations from those values.
- c. Impact of industrial sources will be documented. For projects with significant industrial contributions, evidence of adequate pretreatment strategies will be included along with documentation that industries are aware of the proposed new pretreatment limitations and user costs associated with the project. Documentation of the individual industrial participation in the project plan including user charges will be provided.



- d. Septage and leachate may contribute significant organic load and other materials which can cause operational problems and non-compliance with discharge permit limitations. If septage or leachate is to be discharged to the wastewater treatment facility, consult the state regulatory agency and the Chapter 120.

#### **12.6.1.5.6 Organic Capacity of Wastewater Treatment Facilities to Serve New Collection Systems**

- a. Domestic waste treatment design will be on the basis of at least 0.17 pounds (0.08 kg) of BOD<sub>5</sub> per capita per day and 0.20 pounds (0.09 kg) of suspended solids per capita per day, unless information is submitted to justify alternate designs.
- b. Industrial contributions. Refer to paragraph 12.6.1.5.5(c).
- c. Septage and Leachate. Refer to paragraph 12.6.1.5.5(d).
- d. Data from similar municipalities may be utilized in the case of new systems. However, thorough investigation that is adequately documented will be provided to the reviewing authority to establish the reliability and applicability of such data.

#### **12.6.1.5.7 Wastewater Treatment Facility Design Capacity**

The wastewater treatment facility design capacity is the design average flow at the design average BOD<sub>5</sub>. Refer to paragraphs 12.6.1.4.1 and 12.6.1.5 for peaking factors that will be required.

### **12.6.2 Cost Estimate**

Provide an itemized estimate of the project cost based on the anticipated period of construction. Include development and construction, land and rights-of-way, legal, engineering, interest, equipment, contingencies, refinancing, and any other costs associated with the proposed project. (For projects containing both water and wastewater systems, provide a separate cost estimate for each system.)



### **12.6.3 Annual Operating Budget**

#### **12.6.3.1 Income**

Provide a rate schedule. Project income realistically, based on user billings, wastewater treatment contracts, and other sources of income. In

the absence of other reliable information, for budget purposes, base wastewater generation on 65 gallons per capita per day (gpcd), or 200 gallons per residential-sized connection per day, or 6,000 gallons per residential sized connection per month. When large users are projected, the report will include facts to substantiate such projections and evaluate the impact of such users on the economic viability of the project. The number of users will be based on equivalent dwelling units (DU), which is the level of service provided to a typical rural residential dwelling.

#### **12.6.3.2 Operation and Maintenance**

Project costs realistically. In the absence of other reliable data, base on actual costs of other existing facilities of similar size and complexity. Include facts in the report to substantiate operation and maintenance cost estimates. Include salaries, wages, taxes, accounting and auditing fees, legal fees, interest, utilities, gasoline, oil and fuel, insurance, repairs and maintenance, supplies, chemicals, office supplies and printing, and miscellaneous. Portions of the project that involve complex operation or maintenance requirements will be identified including laboratory requirements for operation, industrial sampling, and self-monitoring.

#### **12.6.3.3 Capital Improvements**

Include all capital improvement costs.

#### **12.6.3.4 Debt Repayment**

Describe existing and proposed project financing from all sources. All estimates of funding will be based on loans, not grants.

#### **12.6.3.5 Reserve**

Unless otherwise required, the reserve will be based on one-tenth (1/10) of the annual debt repayment requirement.



## **12.7 CONCLUSIONS AND RECOMMENDATIONS**

Provide any additional findings and recommendations that will be considered in development of the project. This may include recommendations for special studies, highlight the need for special coordination, a recommended plan of action to expedite project development, etc.

### **12.7.1 Conclusions**

Clearly state conclusions of report.

### **12.7.2 Recommendations**

Clearly state and summarize recommendations. Consider the use of tables.

### **12.7.3 Special Needs**

Identify any special needs.

### **12.7.4 Other**



## CHAPTER 20

### ENGINEERING PLANS AND SPECIFICATIONS

#### 20. PLANS AND SUPPORT DOCUMENTS

Submissions to the reviewing authority will include signed and sealed plans, design criteria, the appropriate construction permit applications, review forms, and permit fee if required, and status of discharge permits (NM Ground Water Discharge Permit and/or NPDES permit).

##### 20.1 GENERAL

###### 20.1.1 Plan Title

All plans for wastewater facilities will bear a suitable title showing the name of the municipality, sewer district, or institution. They will show the scale in feet or metric measure, a graphical scale, the north point, date, and the name and signature of the engineer, with the certificate number and imprint of the professional engineering seal. A space will be provided for signature and/or approval stamp of the appropriate reviewing authority.

###### 20.1.2 Plan Format

The plans will be clear and legible (suitable for microfilming). They will be drawn to a scale that will permit all necessary information to be plainly shown. Generally, the size of the plans will not be larger than 30 inches x 42 inches (762 mm x 1070 mm). Datum used will be indicated. Locations and logs of test borings, when required, will be shown on the plans. Blueprints will not be submitted.

###### 20.1.3 Plan Contents

Detail plans will consist of plan views, elevations, sections, and supplementary views which, together with the specifications and general layouts, provide the working information for the contract and construction of the facilities. They will also include dimensions and relative elevations of structures, the location and outline form of equipment, location and size of piping, water levels, and ground elevations.



#### **20.1.4 Design Criteria**

Design criteria will be included with all plans and specifications and a hydraulic profile will be included for all wastewater treatment facilities. For sewer projects, information will be submitted to verify adequate downstream sewer, pump station and treatment plant capacity.

#### **20.1.5 Operation During Construction**

Project construction documents will specify the procedure for operation during construction that complies with the plan required by Chapter 10 paragraph 12.5.2 (i), Treatment During Construction.

### **20.2 SEWER PLANS**

#### **20.2.1 General Plan**

A plan of proposed and existing sewers will be submitted for projects involving new sewer systems and substantial additions to existing systems. This plan will show the following:

##### **20.2.1.1 Geographical Features**

- a. Topography and elevations.*  
Existing or proposed streets and all streams or water surfaces will be clearly shown.  
Contour lines at suitable intervals will be included.
- b. Streams.*  
The direction of flow in all streams, and high and low water elevations of all water surfaces at sewer outlets and overflows will be shown.
- c. Boundaries.*  
The boundary lines of the municipality or the sewer district, and the area to be sewered, will be shown.

##### **20.2.1.2 Sewers**

The plan will show the location, size, and direction of flow of relevant existing and proposed sanitary draining to the treatment facility concerned.



### **20.2.2 Detail Plans**

Detail plans will be submitted. Profiles will have a horizontal scale of not more than 100 feet to the inch (1200:1) and a vertical scale of not more than 10 feet to the inch (120:1). Plan views will be drawn to a corresponding horizontal scale and will be shown on the same sheet. Plans and profiles will show:

- a. Location of streets and sewers.
- b. Line of ground surface; size, material, and type of pipe; length between manholes; invert and surface elevation at each manhole; and grade of sewer between each two adjacent manholes (all manholes will be numbered on the profile).

Where there is any question of the sewer being sufficiently deep to serve any residence, the elevation and location of the basement floor will be plotted on the profile of the sewer that is to serve the house in question. The engineer will state that all sewers are sufficiently deep to serve adjacent basements except where otherwise noted on the plans.

- c. Locations of all special features such as inverted siphons, concrete encasements, elevated sewers, etc.
- d. All known existing structures and utilities, both above and below ground, which might interfere with the proposed construction or require isolation setback, particularly water mains and water supply structures (i.e. wells, clear wells, basins), gas mains, storm drains, and telephone and power conduits.
- e. Special detail drawings, made to a scale to clearly show the nature of the design, will be furnished to show the following particulars:
  1. All stream crossings and sewer outlets, with elevations of the streambed and normal and extreme high and low water levels.
  2. Details of all special sewer joints and cross-sections; and details of all sewer appurtenances such as manholes, lampholes, inspection chambers, inverted siphons, regulators, and elevated sewers.





## **20.3 PLANS OF WASTEWATER PUMPING STATIONS**

### **20.3.1 Location Plan**

A plan will be submitted for projects involving construction or revision of pumping stations. This plan will show the following:

- a. The location and extent of the tributary area.
- b. Any municipal boundaries within the tributary area.
- c. The location of the pumping station and force main, and pertinent elevations.

### **20.3.2 Detail Plans**

Detail plans will be submitted showing the following, where applicable:

- a. Topography of the site.
- b. Existing pumping station.
- c. Proposed pumping station, including provisions for installation of future pumps, odor control, and backup power if appropriate.
- d. Elevation of high water at the site, and maximum elevation of wastewater in the collection system upon occasion of power failure, including measures for containment if necessary.
- e. Maximum hydraulic gradient in downstream gravity sewers when all installed pumps are in operation.
- f. Test borings and groundwater elevations.

## **20.4 PLANS OF WASTEWATER TREATMENT PLANTS**

### **20.4.1 Location Plan**

A plan will be submitted showing the wastewater treatment plant in relation to the remainder of the system. Sufficient topographic features will be included to indicate its location with relation to all points of discharge of treated effluent.

### **20.4.2 General Layout**

Layouts of the proposed wastewater treatment plant will be submitted, showing:

- a. Topography of the site.



- b. Size and location of plant structures.
- c. Schematic flow diagram(s) showing the flow through various plant units, and showing utility systems serving the plant processes.
- d. Piping, including any arrangements for bypassing individual units (materials handled and direction of flow through pipes will be shown).
- e. Hydraulic profiles showing the flow of wastewater, supernatant liquor, and biosolids.
- f. Test borings and groundwater elevations.

### **20.4.3 Detail Plans**

Detail plans will show the following, where applicable:

- a. Location, dimensions, and elevations of all existing and proposed plant facilities.
- b. Elevations of high and low water level of the body of water to which the plant effluent is to be discharged.
- c. Type, size, pertinent features, and operating capacity of all pumps, blowers, motors, and other mechanical devices.
- d. Minimum, design average, and peak hourly hydraulic flow in profile.
- e. Adequate description of any features not otherwise covered by specifications or engineer's report.

## **21. SPECIFICATIONS**

Complete signed and sealed technical specifications (see paragraph 20.1.1) will be submitted for the construction of sewers, wastewater pumping stations, wastewater treatment plants, and all other appurtenances, and will accompany the plans. The primary funding agencies for wastewater projects in New Mexico have agreed that the "Standard General Conditions of the Construction Contract" as prepared by the Engineer's Joint Contract Document Committee (EJCDC) and as revised by the agencies, is an acceptable form of agreement.

The specifications accompanying construction drawings will include, but not be limited to, specifications for the approved procedures for operation during construction in accordance with Chapter 10 paragraph 12.5.2(i) and paragraph 20.1.5 of this Chapter, all construction information not shown on the drawings which is necessary to inform the builder in detail of the design requirements for the quality of materials, workmanship, and fabrication of the project.



The specifications will also include: the type, size, strength, operating characteristics, and rating of equipment; the complete requirements for all mechanical and electrical equipment, including machinery, valves, piping, and jointing of pipe; electrical apparatus, wiring, instrumentation, and meters; laboratory fixtures and equipment; operating tools, construction materials; special filter materials, such as, stone, sand, gravel, or slag; miscellaneous appurtenances; chemicals when used; instructions for testing materials and equipment as necessary to meet design standards; and performance tests for the completed facilities and component units. It is suggested that these performance tests be conducted at design load conditions wherever practical.

## **22. REVISIONS TO APPROVED PLANS**

Any deviations from approved plans or specifications affecting capacity, flow, operation of units, or point of discharge will be approved, in writing by the owner and funding agency, before such changes are made. Plans or specifications so revised will, therefore, be submitted well in advance of any construction work that will be affected by such changes to permit sufficient time for review and approval. Structural revisions or other minor changes not affecting capacities, flows, or operation will be permitted during construction without approval. As-built plans clearly showing such alterations will be submitted to the reviewing authority at the completion of the work.



## CHAPTER 30

### DESIGN OF SEWERS

#### 31. APPROVAL OF SEWERS

In general, the appropriate reviewing authority will approve plans for new systems, extensions to new areas, or replacement sanitary sewers only when designed upon the separate basis, in which rain water from roofs, streets, and other areas, and groundwater from foundation drains, are excluded.

#### 32. DESIGN CAPACITIES AND DESIGN FLOW

In general, sewer capacities will be designed for the estimated ultimate tributary population, except in considering parts of the systems that can be readily increased in capacity. Similarly, consideration will be given to the maximum anticipated capacity of institutions, industrial parks, etc. Where future relief sewers are planned, economic analysis of alternatives will accompany initial permit applications. See paragraph 12.6.1.4.

#### 33. DETAILS OF DESIGN AND CONSTRUCTION

##### 33.1 MINIMUM SIZE

No public gravity sewer conveying raw wastewater will be less than 8 inches (200 mm) in diameter.

##### 33.2 DEPTH

In general, sewers will be sufficiently deep to receive wastewater from basements (when present) and prevent freezing. Insulation will be provided for sewers that cannot be placed at a depth sufficient to prevent freezing.

##### 33.3 BUOYANCY

Buoyancy of sewers will be considered and flotation of the pipe will be prevented with appropriate construction where high groundwater conditions are anticipated.



## **33.4 SLOPE**

### **33.4.1 Recommended Minimum Slopes**

All sewers will be designed and constructed to give mean velocities, when flowing full, of not less than 2.0 feet per second (0.6 m/s), based on Manning's formula using an "n" value of 0.013. The following are the recommended minimum slopes, which will be provided; however, slopes greater than these are desirable.

<u>Nominal Sewer Size</u>	<u>Minimum Slope in Feet Per 100 Feet (m/100m)</u>
8 inch (200 mm)	0.40
10 inch (250 mm)	0.28
12 inch (300 mm)	0.22
14 inch (350 mm)	0.17
15 inch (375 mm)	0.15
16 inch (400 mm)	0.14
18 inch (450 mm)	0.12
21 inch (525 mm)	0.10
24 inch (600 mm)	0.08
27 inch (675 mm)	0.067
30 inch (750 mm)	0.058
33 inch (825 mm)	0.052
36 inch (900 mm)	0.046
39 inch (975 mm)	0.041
42 inch (1050 mm)	0.037

### **33.4.2 Minimum Flow Depths**

Slopes slightly less than those recommended for the 2.0 feet per second (0.6 m/s) velocity, when flowing full, may be permitted. Such decreased slopes may be considered where the depth of flow will be 0.3 of the diameter or greater for design average flow. The operating authority of the sewer system will give written assurance to the appropriate reviewing authority that any additional sewer maintenance required by reduced slopes will be provided.



### **33.4.3 Minimize Solids Deposition**

The pipe diameter and slope will be selected to obtain the greatest practical velocities to minimize settling problems. Oversize sewers will not be approved to justify using flatter slopes. If the proposed slope is less than the minimum slope of the smallest pipe which can accommodate the design peak hourly flow, the actual depths and velocities at minimum, average, and design maximum day and peak hourly flow for each design section of the sewer will be calculated by the design engineer and be included with the plans.

### **33.4.4 Slopes Between Manholes**

Sewers will be laid with uniform slope between manholes.

### **33.4.5 High Velocity Protection**

Where velocities greater than 15 feet per second (4.6 m/s) are attained, special provision will be made to protect against displacement by erosion and impact.

### **33.4.6 Steep Slope Protection**

Sewers on 20 percent slopes or greater will be anchored securely with concrete, or other acceptable anchor system, spaced as follows:

1. Not over 36 feet (11 m) center to center on grades 20 percent and up to 35 percent;
2. Not over 24 feet (7.3 m) center to center on grades 35 percent and up to 50 percent; and
3. Not over 16 feet (4.9 m) center to center on grades 50 percent and over.
4. Pursuant to manufacturer's specifications for alternate anchoring systems.

## **33.5 ALIGNMENT**

In general, sewers 24 inches (600 mm) or less will be laid with straight alignment between manholes. Straight alignment will be checked by either using a laser beam or lamping.

Curvilinear alignment of sewers larger than 24 inches (600 mm) may be considered on a case-by-case basis providing compression joints are specified and ASTM or specific pipe manufacturers' maximum allowable pipe joint



deflection limits are not exceeded. Curvilinear sewers will be limited to simple curves, which start and end at manholes. When curvilinear sewers are proposed, minimum slopes indicated in paragraph 33.4.1 will be increased accordingly to provide a recommended minimum velocity of 2.0 feet per second (0.6 m/s) when flowing full.

### **33.6 CHANGES IN PIPE SIZE**

When a smaller sewer joins a large one, the invert of the larger sewer will be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation.

Sewer extensions will be designed for projected flows even when the diameter of the receiving sewer is less than the diameter of the proposed extension at a manhole constructed in accordance with Section 34 with special consideration of an appropriate flow channel to minimize turbulence when there is a change in sewer size. The appropriate reviewing authority may require a schedule for construction of future downstream sewer relief.

### **33.7 MATERIALS**

Any generally accepted material for sewers will be given consideration, but the material selected will be adapted to local conditions, such as character of industrial wastes, possibility of septicity, soil characteristics, exceptionally heavy external loadings, abrasion, corrosion, and similar problems.

Suitable couplings complying with ASTM specifications will be used for joining dissimilar materials. The leakage limitations on these joints will be in accordance with paragraphs 33.9.4 or 33.9.5.

All sewers will be designed to prevent damage from superimposed live, dead, and frost induced loads. Proper allowance for loads on the sewer will be made because of soil and potential groundwater conditions, as well as the width and depth of trench. Where necessary, special bedding, haunching and initial backfill, concrete cradle, or other special construction will be used to withstand anticipated potential superimposed loading or loss of trench wall stability. See ASTM D 2321 or ASTM C 12 when appropriate.



For new pipe materials for which ASTM standards have not been established, the design engineer will provide complete pipe specifications and installation specifications developed on the basis of criteria adequately documented and certified in writing by the pipe manufacturer to be satisfactory for the specific detailed plans.

## **33.8 INSTALLATION**

### **33.8.1 Standards**

Installation specifications will contain appropriate requirements based on the criteria, standards, and requirements established by industry in its technical publications. Requirements will be set forth in the specifications for the pipe and methods of bedding and backfilling thereof so as not to damage the pipe or its joints, impede cleaning operations and future tapping, nor create excessive side fill pressures and ovalation of the pipe, nor seriously impair flow capacity.

### **33.8.2 Trenching**

- a. The width of the trench will be ample to allow the pipe to be laid and jointed properly and to allow the bedding and haunching to be placed and compacted to adequately support the pipe. The trench sides will be kept as nearly vertical as possible. When wider trenches are specified, appropriate bedding class and pipe strength will be used.

In unsupported, unstable soil, the size and stiffness of the pipe, stiffness of the embedment and insitu soil and depth of cover will be considered in determining the minimum trench width necessary to adequately support the pipe.

- b. Ledge rock, boulders, and large stones will be removed to provide a minimum clearance of 4 inches (100 mm) below and on each side of all pipe(s).

### **33.8.3 Bedding, Haunching, and Initial Backfill**

- a. Bedding Classes A, B, C, or crushed stone as described in ASTM C 12 will be used and carefully compacted for all rigid pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load, based on the soil type encountered and potential ground water conditions.





- b. Embedment materials for bedding, haunching and initial backfill, Classes I, II, or III, as described in ASTM D 2321, will be used and carefully compacted for all flexible pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load, based on the type soil encountered and potential groundwater conditions.
- c. All water entering the excavations or other parts of the work will be removed until all the work has been completed. No sanitary sewer will be used for the disposal of trench water, unless specifically approved by the engineer, and then only if the trench water does not ultimately arrive at existing pumping or wastewater treatment facilities.

#### **33.8.4 Final Backfill**

- a. Final backfill will be of a suitable material removed from excavation except where other material is specified. Debris, frozen material, large clods or stones, organic matter, or other unstable materials will not be used for final backfill within 2 feet (600 mm) of the top of the pipe.
- b. Final backfill will be placed in such a manner as not to disturb the alignment of the pipe.

#### **33.8.5 Deflection Test**

- a. Deflection tests will be performed on all flexible pipe. The test will be conducted after the final backfill has been in place at least 30 days to permit stabilization of the soil-pipe system.
- b. No pipe will exceed a deflection of 5 percent. If deflection exceeds 5 percent, replacement or correction will be accomplished in accordance with requirements in the approved specifications.
- c. The rigid ball or mandrel used for the deflection test will have a diameter not less than 95 percent of the base inside diameter or average inside diameter of the pipe depending on which is specified in the ASTM Specification, including the appendix, to which the pipe is manufactured. The test will be performed without mechanical pulling devices.



## **33.9 JOINTS AND INFILTRATION**

### **33.9.1 Joints**

The installation of joints and the materials used will be included in the specifications. Sewer joints will be designed to minimize infiltration and to prevent the entrance of roots throughout the life of the system.

### **33.9.2 Service Connections**

Service connections to the sewer main will be watertight and not protrude into the sewer. If a saddle type connection is used, it will be a device designed to join with the types of pipe which are to be connected. All materials used to make service connections will be compatible with each other and with the pipe materials to be joined and will be corrosion proof.

### **33.9.3 Leakage Tests**

Leakage tests will be specified. This may include appropriate water or low pressure air testing. The testing methods selected will take into consideration the range in groundwater elevations during the test and anticipated during the design life of the sewer.

#### **33.9.3.1 *Water (Hydrostatic) Test***

The leakage exfiltration or infiltration will not exceed 200 gallons per inch of pipe diameter per mile per day ( $0.02 \text{ m}^3/\text{mm of pipe dia./klo/day}$ ) for any section of the system. An exfiltration or infiltration test will be performed with a minimum positive head of 2 feet (600 mm).

#### **33.9.3.2 *Air test***

The air test will, as a minimum, conform to the test procedure described in ASTM C 828 for clay pipe, ASTM C 924 for concrete pipe, ASTM F 1417 for plastic pipe, and for other materials test procedures approved by the regulatory agency.



## **34. MANHOLES**

### **34.1 LOCATION**

Manholes will be installed: at the end of each line; at all changes in grade, size, or alignment; at all intersections; and at distances not greater than 400 feet (120 m) for sewers 15 inches (375 mm) or less, and 500 feet (150 m) for sewers 18 inches (450 mm) to 30 inches (750 mm). Distances up to 600 feet (185 m) may be approved in cases where adequate modern cleaning equipment for such spacing is provided. Greater spacing may be permitted in larger sewers. Cleanouts may be used only for special conditions and will not be substituted for manholes nor installed at the end of laterals greater than 150 feet (45 m) in length.

### **34.2 DROP TYPE**

A drop pipe will be provided for a sewer entering a manhole at an elevation of 24 inches (610 mm) or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches (610 mm), the invert will be filleted to prevent solids deposition.

Drop manholes will be constructed with an outside drop connection. Inside drop connections (when necessary) will be secured to the interior wall of the manhole and provide access for cleaning.

Due to the unequal earth pressures that will result from the backfilling operation in the vicinity of the manhole, the engineer will evaluate soil conditions and determine whether the entire outside drop connection will be encased in concrete.

### **34.3 DIAMETER**

The minimum diameter of manholes will be 48 inches (1.2 m); larger diameters are preferable for large diameter sewers. A minimum access diameter of 22 inches (560 mm) will be provided.

### **34.4 FLOW CHANNEL**

The flow channel straight through a manhole will be made to conform as closely as possible in shape, and slope to that of the connecting sewers. The channel walls will be formed or shaped to the full height of the crown of the outlet sewer in such a manner to not obstruct maintenance, inspection or flow in the sewers.



When curved flow channels are specified in manholes, including branch inlets, minimum slopes indicated in paragraph 33.4.1 will be increased to maintain acceptable velocities.

#### **34.5 BENCH**

A bench will be provided on each side of any manhole channel when the pipe diameter(s) are less than the manhole diameter. The bench will be sloped no less than 1/2 inch (13 mm) per foot (305 mm) (4 percent). No lateral sewer, service connection, or drop manhole pipe will discharge onto the surface of the bench.

#### **34.6 WATER TIGHTNESS**

Manholes will be of the pre-cast concrete or poured-in-place concrete type. Manhole lift holes and grade adjustment rings will be sealed with non-shrinking mortar or other material approved by the regulatory agency.

Inlet and outlet pipes will be joined to the manhole with a gasketed flexible watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place.

Watertight manhole covers are to be used wherever the manhole tops may be flooded by street runoff or high water. Locked manhole covers may be desirable in isolated easement locations or where vandalism may be a problem.

#### **34.7 INSPECTION AND TESTING**

The specifications will include a requirement for inspection and testing for water tightness or damage prior to placing into service. Air testing, if specified for concrete sewer manholes, will conform to the test procedures described in ASTM C 1244.

#### **34.8 CORROSION PROTECTION FOR MANHOLES**

Where corrosive conditions due to septicity or other causes is anticipated, consideration will be given to providing corrosion protection on the interior of the manholes.



### **34.9 ELECTRICAL**

Electrical equipment installed or used in manholes will conform to Chapter 40 paragraph 42.3.5.

### **35. INVERTED SIPHONS**

Inverted siphons will have not less than two barrels, with a minimum pipe size of 6 inches (150 mm). They will be provided with necessary appurtenances for maintenance, convenient flushing, and cleaning equipment. The inlet and discharge structures will have adequate clearances for cleaning equipment, inspection, and flushing. Design will provide sufficient head and appropriate pipe sizes to secure velocities of at least 3.0 feet per second (0.9 m/s) for design average flows. The inlet and outlet details will be so arranged that the design average flow is diverted to one barrel, and so that either barrel may be cut out of service for cleaning. The vertical alignment will permit cleaning and maintenance.

### **36. SEWERS IN RELATION TO STREAMS**

#### **36.1 LOCATION OF SEWERS IN STREAMS**

##### **36.1.1 Cover Depth**

The top of all sewers entering or crossing streams will be at a sufficient depth below the natural bottom of the streambed to protect the sewer line. In general, the following cover requirements will be met:

- a. One foot (305 mm) of cover where the sewer is located in rock;
- b. Three feet (910 mm) of cover in other material. In major streams, more than three feet (910 mm) of cover may be required; and
- c. In paved stream channels, the top of the sewer line will be placed below the bottom of the channel pavement.

Less cover will be approved only if the proposed sewer crossing will not interfere with the future improvements to the stream channel. Reasons for requesting less cover will be provided in the project proposal.

##### **36.1.2 Horizontal Location**

Sewers located along streams will be located outside of the streambed and sufficiently removed therefrom to provide for future possible stream widening and to prevent pollution by siltation during construction.



### **36.1.3 Structures**

The sewer outfalls, headwalls, manholes, gate boxes, or other structures will be located so they do not interfere with the free discharge of flood flows of the stream.

### **36.1.4 Alignment**

Sewers crossing streams will be designed to cross the stream as nearly perpendicular to the stream flow as possible and will be free from change in grade. Sewer systems will be designed to minimize the number of stream crossings.

## **36.2 CONSTRUCTION**

### **36.2.1 Materials**

Sewers entering or crossing streams will be constructed of ductile iron pipe with mechanical joints; otherwise they will be constructed so they will remain watertight and free from changes in alignment or grade. Material used to backfill the trench will be stone, coarse aggregate, washed gravel, or other materials which will not readily erode, cause siltation, damage pipe during placement, or corrode the pipe.

### **36.2.2 Siltation and Erosion**

Construction methods that will minimize siltation and erosion will be employed. The design engineer will include in the project specifications the method(s) to be employed in the construction of sewers in or near streams. Such methods will provide adequate control of siltation and erosion by limiting unnecessary excavation, disturbing or uprooting trees and vegetation, dumping of soil or debris, or pumping silt-laden water into the stream. Specifications will require that cleanup, grading, seeding, and planting or restoration of all work areas will begin immediately. Exposed areas will not remain unprotected for more than seven days.

## **37. AERIAL CROSSINGS**

Support will be provided for all joints in pipes utilized for aerial crossings. The supports will be designed to prevent frost heave, overturning, and settlement. Precautions against freezing, such as insulation and increased slope, will be provided.



Expansion jointing will be provided between above ground and below ground sewers. Where buried sewers change to aerial sewers, special construction techniques will be used to minimize frost heaving.

For aerial stream crossings, the impact of floodwaters and debris will be considered. The bottom of the pipe will be placed no lower than the elevation of the 50-year flood. Ductile iron pipe with mechanical joints is recommended.

### **38. PROTECTION OF WATER SUPPLIES**

When wastewater sewers are proposed in the vicinity of any water supply facilities, requirements of the Guidelines for Water Supply Systems and Treatment Works in New Mexico “Recommended Standards for Water Works” will be used to confirm acceptable isolation distances in addition to the following requirements:

#### **38.1 CROSS CONNECTIONS PROHIBITED**

There will be no physical connections between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any wastewater or polluted water into the potable supply. No water pipe will pass through or come into contact with any part of a sewer manhole.

#### **38.2 RELATION TO WATER WORKS STRUCTURES**

While no general statement can be made to cover all conditions, it is generally recognized that sewers will meet the requirements of the appropriate reviewing agency with respect to minimum distances from public water supply wells or other water supply sources and structures.

All existing waterworks units, such as basins, wells, or other treatment units, within 200 feet (60 m) of the proposed sewer will be shown on the engineering plans.

Soil conditions in the vicinity of the proposed sewer within 200 feet (60 m) of waterworks units will be determined and shown on the engineering plans.

#### **38.3 RELATION TO WATER MAINS**

##### **38.3.1 Horizontal and Vertical Separation**

Sewers will be laid at least 10 feet (3 m) horizontally from any existing or proposed water main. The distance will be measured edge to edge. In cases



where it is not practical to maintain a 10-foot (3 m) separation, the appropriate reviewing agency may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such deviation may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the water main is at least 18 inches (460 mm) above the top of the sewer.

If it is impossible to obtain proper horizontal and vertical separation as described above, both the water main and sewer will be constructed of slip-on or mechanical joint pipe complying with public water supply design standards of the agency and be pressure tested to 150 psi (1034 kPa) to assure water tightness before backfilling.

### **38.3.2 Crossings**

Sewers crossing water mains will be laid to provide a minimum vertical distance of 18 inches (460 mm) between the outside of the water main and the outside of the sewer. This will be the case where the water main is either above or below the sewer. The crossing will be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support will be provided for the sewer to maintain line and grade.

When it is impossible to obtain proper horizontal and vertical separation as stipulated above, one of the following methods will be specified:

- a. The sewer will be designed and constructed equal to water pipe, and will be pressure tested at 150 psi (1034 kPa) to assure water tightness prior to backfilling.
- b. Either the water main or the sewer line may be encased in a watertight carrier pipe, which extends 10 feet (3 m) on both sides of the crossing, measured perpendicular to the water main. The carrier pipe will be of materials approved by the regulatory agency for use in water main construction.





## CHAPTER 40

### WASTEWATER PUMPING STATIONS

#### 41. GENERAL

##### 41.1 FLOODING

Wastewater pumping station structures and electrical and mechanical equipment will be protected from physical damage by the 100-year flood. Wastewater pumping stations will remain fully operational and accessible during the 25-year flood. Regulations of state, local, and federal agencies regarding flood plain obstructions will be considered.

##### 41.2 ACCESSIBILITY AND SECURITY

The pumping station will be readily accessible by maintenance vehicles during all weather conditions. The facility will be located off the traffic way of streets and alleys. It is recommended that security fencing and access hatches with locks be provided.

##### 41.3 GRIT

Where it is necessary to pump wastewater prior to grit removal, the design of the wet well and pump station piping will receive special consideration to avoid operational problems from the accumulation of grit.

##### 41.4 SAFETY

Adequate provision will be made to effectively protect maintenance personnel from hazards. Equipment for confined space entry in accordance with OSHA and regulatory agency requirements will be provided for all wastewater pumping stations. Also refer to Section 57.

#### 42. DESIGN

The following items will be given consideration in the design of wastewater pumping stations:



## **42.1 TYPE**

Wastewater pumping stations in general use fall into four types: wet well/dry well, suction lift, submersible, and screw pump.

## **42.2 STRUCTURES**

### **42.2.1 Separation**

Dry wells, including their superstructure, will be completely separated from the wet well. Common walls will be gas tight.

### **42.2.2 Equipment Removal**

Adequate provision will be made to facilitate removing pumps, motors, and other mechanical and electrical equipment.

### **42.2.3 Access and Safety Landings**

#### **42.2.3.1 Access**

Suitable and safe means of access for persons wearing self-contained breathing apparatus will be provided to dry wells, and to wet wells. Access to wet wells containing either bar screens or mechanical equipment requiring inspection or maintenance will conform to Chapter 60, Section 61. Also refer to Chapter 50, Section 57.

#### **42.2.3.2 Safety Landings**

For built-in place pump stations, a stairway to the dry well will be provided with rest landings at vertical intervals not to exceed 12 feet (3.7 m). For factory-built pump stations over 15 feet deep (4.6 m), a rigidly fixed landing will be provided at vertical intervals not to exceed 10 feet (3 m). Where a landing is used, a suitable and rigidly fixed barrier will be provided to prevent an individual from falling past the intermediate landing to a lower level. A man lift or elevator may be used in lieu of landings in a factory-built station, provided emergency access is included in the design.



#### **42.2.4 Buoyancy**

Where high groundwater conditions are anticipated, buoyancy of the wastewater pumping station structures will be considered and, if necessary, adequate provisions will be made for protection.

#### **42.2.5 Construction Materials**

Materials will be selected that are appropriate under conditions of exposure to hydrogen sulfide and other corrosive gases, greases, oils, acids and other constituents frequently present in wastewater. This is particularly important in the selection of metals and paints. Contact between dissimilar metals will be avoided or other provisions made to minimize galvanic action.

### **42.3 PUMPS**

#### **42.3.1 Multiple Units**

Multiple pumps will be provided. Where only two units are provided, they will be of the same size. Units will have capacity such that, with any unit out of service, the remaining units will have capacity to handle 100% of the design peak hourly flow. All pumps will be tested by the manufacturer. These tests will include a hydrostatic test and an operating test.

#### **42.3.2 Protection Against Clogging**

##### **42.3.2.1 *Separate Sanitary Wastewater***

Pumps handling sewage from 30-inch (760 mm) or larger diameter sewers will be protected from clogging or damage, by readily accessible bar racks or suitably designed screen/grinder systems. Bar racks will have clear openings not exceeding 1-1/2 inches (38 mm). The design will provide for a mechanical hoist. The design engineer will consider installation of mechanically cleaned and duplicate bar racks in the pumping stations handling larger than five million gallons per day. Appropriate protection from clogging will also be considered for small pumping stations. Refer to paragraph 42.2.3 and Chapter 60, Section 61.



### **42.3.3 Pump Openings**

Pumps handling raw wastewater will be capable of passing spheres of at least 3 inches (80 mm) in diameter. Pump suction and discharge openings will be at least 4 inches (100 mm) in diameter.

### **42.3.4 Priming**

The pump will be so placed that under normal operating conditions it will operate under a positive suction head, except as specified in Section 43.

### **42.3.5 Electrical Equipment**

Electrical systems and components (e.g., motors, lights, cables, conduits, switch boxes, control circuits, etc.) in raw wastewater wet wells, or in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present, will comply with the National Electrical Code requirements for Class I Group D, Division 1 locations.

In addition, equipment located in the wet well will be suitable for use under corrosive conditions. Each flexible cable will be provided with a watertight seal and separate strain relief. A fused disconnect switch located above ground will be provided for the main power feed for all pumping stations. When such equipment is exposed to weather, it will meet the requirements of weatherproof equipment NEMA 3R or 4. Lightning and surge protection systems will be considered. A 110-volt power receptacle to facilitate maintenance will be provided inside the control panel for lift stations that have control panels outdoors. Ground fault interruption protection will be provided for all outdoor outlets.

### **42.3.6 Intake**

Each pump will have an individual intake. Wet well and intake design will be such as to avoid turbulence near the intake and to prevent vortex formation.

### **42.3.7 Dry Well Dewatering**

A sump pump equipped with dual check valves will be provided in the dry well to remove leakage or drainage with discharge above the maximum high water level of the wet well. Water ejectors connected to a potable water supply will not be approved. All floor and walkway surfaces will have an adequate slope to a point



of drainage. Pump seal leakage will be piped or channeled directly to the sump. The sump pump will be sized to remove the maximum pump seal water discharge, which would occur in the event of a pump seal failure. Refer to Section 45.

#### **42.3.8 Pumping Rates**

The pumps and controls of main pumping stations, and especially pumping stations operated as part of treatment facilities, will be selected to operate at varying delivery rates. Insofar as is practicable, such stations will be designed to deliver as uniform a flow as practicable in order to minimize hydraulic surges. The station design capacity will be based on peak hourly flow as determined in accordance with Section 12.6.1.4 and will be adequate to maintain a minimum velocity of 2 feet per second (0.60 m/s) in the force main except as noted in. Refer to paragraph 48.1.

### **42.4 CONTROLS**

Control floats, float tubes, and bubbler lines or other devices, will be so located as not to be unduly affected by turbulent flows entering the well or by the turbulent suction of the pumps. Provision will be made to automatically alternate the pumps in use.

### **42.5 VALVES**

#### **42.5.1 Suction Line**

Suitable shutoff valves will be placed on the suction line of dry pit pumps.

#### **42.5.2 Discharge Lines**

Suitable shutoff and check valves will be placed on the discharge line of each pump (except on screw pumps). The check valve will be located between the shutoff valve and the pump. Check valves will be suitable for the material being handled and will be placed on the horizontal portion of discharge piping except for ball checks, which may be placed in the vertical run. Valves will be capable of withstanding normal pressure and water hammer.

All shutoff and check valves will be operable from the floor level and accessible for maintenance. Outside levers are recommended on swing check valves.



## **42.6 WET WELLS**

### **42.6.1 Divided Wells**

Where continuity of pumping station operation is critical, consideration will be given to dividing the wet well into two multiple sections, properly interconnected, to facilitate repairs and cleaning.

### **42.6.2 Size**

The design fill time and minimum pump cycle time will be considered in sizing the wet well. The effective volume of the wet well will be based on design average flow and a filling time not to exceed 30 minutes unless the facility is designed to provide flow equalization. The pump manufacturer's duty cycle recommendations will be utilized in selecting the minimum cycle time. When the anticipated initial flow tributary to the pumping station is less than the design average flow, provisions will be made so that the fill time indicated is not exceeded for initial flows. When the wet well is designed for flow equalization as part of a treatment plant, provisions will be made to prevent septicity.

### **42.6.3 Floor Slope**

The wet well floor will have a minimum slope of 1 to 1 to the hopper bottom. The horizontal area of the hopper bottom will be no greater than necessary for proper installation and function of the inlet, or to accommodate pumps.

### **42.6.4 Air Displacement**

Covered wet wells will have provisions for air displacement to the atmosphere, such as an inverted "j" tube or other means.

## **42.7 SAFETY VENTILATION**

### **42.7.1 General**

Adequate ventilation will be provided for all pump stations. Where the dry well is below the ground surface, mechanical ventilation is required. If screens or mechanical equipment requiring maintenance or inspection are located in the wet well, permanently installed ventilation is required. There will be no interconnection between the wet well and dry well ventilation systems. See also paragraph 41.4 and Chapter 50, Section 57.



#### **42.7.2 Air Inlets and Outlets**

In dry wells over 15 feet (4.6 m) deep, multiple inlets and outlets are desirable. Dampers will not be used on exhaust or fresh air ducts. Fine screens or other obstructions in air ducts will be avoided to prevent clogging.

#### **42.7.3 Electrical Controls**

Switches for operation of ventilation equipment will be marked and located conveniently. All intermittently operated ventilation equipment will be interconnected with the respective pit lighting system. Consideration will be given also to automatic controls where intermittent operation is used. The manual lighting/ventilation switch will override the automatic controls. For a two speed ventilation system with automatic switch over where gas detection equipment is installed, consideration will be given to increasing the ventilation rate automatically in response to the detection of hazardous concentrations of gases or vapors.

#### **42.7.4 Fans Heating, and Dehumidification**

The fan wheel will be fabricated from non-sparking material. Automatic heating and dehumidification equipment will be provided in all dry wells. The electrical equipment and components will meet the requirements in paragraph 42.3.5.

#### **42.7.5 Wet Wells**

Wet well ventilation may be either continuous or intermittent. Ventilation, if continuous, will provide at least 12 complete air changes per hour; if intermittent, at least 30 complete air changes per hour. Air will be forced into the wet well by mechanical means rather than solely exhausted from the wet well. The air change requirements will be based on 100 percent fresh air. Portable ventilation equipment will be provided for use at submersible pump stations and wet wells with no permanently installed ventilation equipment.

#### **42.7.6 Dry Wells**

Dry well ventilation may be either continuous or intermittent. Ventilation, if continuous, will provide at least 6 complete air changes per hour; if intermittent, at least 30 complete air changes per hour. A system of two-speed ventilation with an initial ventilation rate of 30 changes per hour for 10 minutes and automatic switch over to 6 changes per hour may be used to conserve heat. The air change requirements will be based on 100 percent fresh air.



## **42.8 FLOW MEASUREMENT**

Suitable devices for measuring wastewater flow will be provided at all pumping stations. Indicating, totalizing, and recording flow measurement will be provided at pumping stations with a 1200 gpm (75 L/s) or greater design peak flow. Elapsed time meters used in conjunction with annual pumping rate tests may be acceptable for pump stations with a design peak hourly flow up to 1200 gpm (75 L/s) provided sufficient metering is configured to measure the duration of individual and simultaneous pump operation.

## **42.9 WATER SUPPLY**

There will be no physical connection between any potable water supply and a wastewater pumping station, which under any conditions might cause contamination of the potable water supply. If a potable water supply is brought to the station, it will comply with backflow prevention conditions stipulated under Chapter 50, paragraph 56.2.3.

## **43. SUCTION-LIFT PUMP STATIONS**

Suction-lift pumps will meet the applicable requirements of Section 42.

### **43.1 PUMP PRIMING AND LIFT REQUIREMENTS**

Suction-lift pumps will be of the self-priming or vacuum-priming type. Suction-lift pump stations using dynamic suction lifts exceeding the limits outlined in the following sections may be approved upon submission of factory certification of pump performance and detailed calculations indicating satisfactory performance under the proposed operating conditions. Such detailed calculations will include static suction-lift as measured from “lead pump off” elevation to centerline of pump suction, friction, and other hydraulic losses of the suction piping, vapor pressure of the liquid, altitude correction, required net positive suction head, and a safety factor of at least 6 feet (1.8 m).

#### **43.1.1 Self-Priming Pumps**

Self-priming pumps will be capable of rapid priming and repriming at the “lead pump on” elevation. Such self-priming and repriming will be accomplished automatically under design operating conditions. Suction piping will not exceed the size of the pump suction and will not exceed 25 feet (7.6 m) in total length. Priming lift at the “lead pump on” elevation will include a safety factor of at least 4 feet (1.2 m) from the maximum allowable priming lift for the specific equipment





at design operating conditions. The combined total of dynamic suction-lift at the “pump off” elevation and required net positive suction head at design operating conditions will not exceed 22 feet (6.7 m).

#### **43.1.2 Vacuum-Priming Pumps**

Vacuum-priming pump stations will be equipped with dual vacuum pumps capable of automatically and completely removing air from the suction-lift pump. The vacuum pumps will be adequately protected from damage due to wastewater. The combined total of dynamic suction-lift at the “pump off” elevation and required net positive suction head at design operating conditions will not exceed 22 feet (6.7 m).

### **43.2 EQUIPMENT, WET WELL ACCESS, AND VALVING LOCATION**

The pump equipment compartment will be above grade or offset and will be effectively isolated from the wet well to prevent a hazardous and corrosive sewer atmosphere from entering the equipment compartment. Wet well access will not be through the equipment compartment and will be at least 24 inches (610 mm) in diameter. Gasketed replacement plates will be provided to cover the opening to the wet well for pump units removed for servicing. Valving will not be located in the wet well.

## **44. SUBMERSIBLE PUMP STATIONS – SPECIAL CONSIDERATIONS**

Submersible pump stations will meet the applicable requirements under Section 42, except as modified in this Section.

### **44.1 CONSTRUCTION**

Submersible pumps and motors will be designed specifically for raw wastewater use, including totally submerged operation during a portion of each pumping cycle and will meet the requirements of the National Electrical Code for such units. An effective method to detect shaft seal failure or potential seal failure will be provided.

### **44.2 PUMP REMOVAL**

Submersible pumps will be readily removable and replaceable without dewatering the wet well or disconnecting any piping in the wet well.



## **44.3 ELECTRICAL EQUIPMENT**

### **44.3.1 Power Supply and Control Circuitry**

Electrical supply, control, and alarm circuits will be designed to provide strain relief and to allow disconnection from outside the wet well. Terminals and connectors will be protected from corrosion by location outside the wet well or through use of watertight seals.

### **44.3.2 Controls**

The motor control center will be located outside the wet well, be readily accessible, and be protected by a conduit seal or other appropriate measures meeting the requirements of the National Electrical Code, to prevent the atmosphere of the wet well from gaining access to the control center. The seal will be so located that the motor may be removed and electrically disconnected without disturbing the seal. When such equipment is exposed to weather, it will meet the requirements of weatherproof equipment NEMA 3R or 4.

### **44.3.3 Power Cord**

Pump motor power cords will be designed for flexibility and serviceability under conditions of extra hard usage and will meet the requirements of the National Electrical Code standards for flexible cords in wastewater pump stations. Ground fault interruption protection will be used to de-energize the circuit in the event of any failure in the electrical integrity of the cable. Power cord terminal fittings will be corrosion-resistant and constructed in a manner to prevent the entry of moisture into the cable, will be provided with strain relief appurtenances, and will be designed to facilitate field connecting.

### **44.3.4 Valves**

Valves required under paragraph 42.5 will be located in a separate valve pit. Provisions will be made to remove or drain accumulated water from the valve pit. The valve pit may be dewatered to the wet well through a drain line with a gas and watertight valve. Check valves that are integral to the pump need not be located in a separate valve pit provided that the valve can be removed from the wet well in accordance with paragraph 44.2.

A short individual force main for each pump, may be approved by NMED in lieu of a discharge manifold, where limited pump backspin will not damage the pump and low discharge head conditions exist.



## **45. ALARM SYSTEMS**

Alarm systems will be provided for pumping stations. The alarm will be activated in cases of power failure, sump pump failure, pump failure, unauthorized entry, or any cause of pump station malfunction. Pumping station alarms will be telemetered to a municipal facility that is manned 24 hours a day. If such a facility is not available and a 24-hour holding capacity is not provided, the alarm will be telemetered to city offices during normal working hours and to the home of the responsible person(s) in charge of the lift station during off-duty hours. Audio-visual alarm systems with a self-contained power supply may be acceptable in some cases in lieu of the telemetering system outlined above, depending upon location, station holding capacity and inspection frequency.

An audio-visual alarm system (red flashing light and horn), with a self-contained backup power supply, will be provided for all lift stations. These alarm systems will be telemetered to a facility where 24-hour attendance is available. The alarm system will be activated in case of power outage, pump failure or a specified high water level.

## **46. EMERGENCY OPERATION**

### **46.1 OBJECTIVE**

The objective of emergency operation is to prevent the discharge of raw or partially treated wastewater to any waters and to protect public health by preventing back-up of wastewater and subsequent discharge to basements, street, and other public and private property.

### **46.2 EMERGENCY PUMPING CAPABILITY**

Emergency pumping capability is required unless on-system overflow prevention is provided by adequate storage capacity. Emergency pumping capability may be accomplished by connection of the station to at least two independent utility substations, or by provision of portable or in-place internal combustion engine equipment, which will generate electrical or mechanical energy, or by the provision of portable pumping equipment. Such emergency standby systems will have sufficient capacity to start up and maintain the total rated running capacity of the station. Regardless of the type of emergency standby system provided, a riser from the force main with rapid connection capabilities and appropriate valving will be provided for all lift stations to hook up portable pumps.



### 46.3 EMERGENCY HIGH LEVEL OVERFLOWS

For use during possible periods of extensive power outages, mandatory power reductions, or uncontrollable emergency conditions, consideration will be given to providing a controlled, high-level wet well overflow to supplement alarm systems and emergency power generation in order to prevent backup of wastewater into basements, or other discharges which may cause severe adverse impacts on public interests, including public health and property damage. Where a high level overflow is utilized, consideration will also be given to the installation of storage/detention tanks, or basins, which will be made to drain to the station wet well. Where such overflows affect public water supplies or other critical water uses, the regulatory agency will be contacted for the necessary treatment or storage requirements.

### 46.4 EMERGENCY EQUIPMENT REQUIREMENTS

#### 46.4.1 General

The following general requirements will apply to all internal combustion engines used to drive auxiliary pumps, service pumps through special drives, or electrical generating equipment:

##### **46.4.1.1      *Engine Protection***

The engine will be protected from operating conditions that would result in damage to equipment. Unless continuous manual supervision is planned, protective equipment will be capable of shutting down the engine and activating an alarm on site and as provided in Section 45. Protective equipment will monitor for conditions of low oil pressure and overheating, except that oil pressure monitoring will not be required for engines with splash lubrication.

##### **46.4.1.2      *Size***

The engine will have adequate rated power to start and continuously operate under all connected loads.

##### **46.4.1.3      *Fuel Type***

Reliability and ease of starting, especially during cold weather conditions, will be considered in the selection of the type of fuel.



#### **46.4.1.4      *Underground Fuel Storage***

Underground or aboveground fuel storage and piping facilities will be constructed in accordance with applicable state, local, and federal regulations.

#### **46.4.1.5      *Engine Ventilation***

The engine will be located above grade with adequate ventilation of fuel vapors and exhaust gases.

#### **46.4.1.6      *Routine Start-up***

All emergency equipment will be provided with instructions indicating the need for regular starting and running of such units at full loads.

#### **46.4.1.7      *Protection of Equipment***

Emergency equipment will be protected from damage at the restoration of regular electrical power.

### **46.4.2      *Engine-Driven Pumping Equipment***

Where permanently installed or portable engine-driven pumps are used, the following requirements in addition to general requirements will apply:

#### **46.4.2.1      *Pumping Capacity***

Engine-driven pumps will meet the design pumping requirements unless storage capacity is available for flows in excess of pump capacity. Pumps will be designed for anticipated operating conditions, including suction lift if applicable.

#### **46.4.2.2      *Operation***

The engine and pump will be equipped to provide automatic start-up and operating of pumping equipment unless manual start-up and operating is justified. Provisions will also be made for manual start-up. Where manual start-up and operating is justified, storage capacity and alarm system will meet the requirements of paragraph 46.4.2.3.



#### **46.4.2.3      *Portable Pumping Equipment***

Where part or all of the engine-driven pumping equipment is portable, sufficient storage capacity with alarm system will be provided to allow time for detection of pump station failure and transportation and hookup of the portable equipment.

#### **46.4.3    *Engine-Driven Generating Equipment***

Where permanently installed or portable engine-driven generating equipment is used, the following requirements will apply in addition to general requirements of paragraph 46.4.1:

##### **46.4.3.1      *Generating Capacity***

- a.      Generating unit size will be adequate to provide power for pump motor starting current and for lighting, ventilation, and other auxiliary equipment necessary for safety and proper operation of the lift station.
- b.      The operation of only one pump during periods of auxiliary power supply will be justified. Such justification may be made on the basis of the design peak hourly flows relative to single-pump capacity, anticipated length of power outage, and storage capacity.
- c.      Special sequencing controls will be provided to start pump motors unless the generating equipment has capacity to start all pumps simultaneously with auxiliary equipment operating.

##### **46.4.3.2      *Operation***

Provisions will be made for automatic and manual start-up and load transfer unless only manual start-up and operating is justified. The generator will be protected from operating conditions that would result in damage to equipment. Provisions will be considered to allow the engine to start and stabilize at operating speed before assuming the load. Where manual start-up and transfer is justified, storage capacity and alarm system will meet the requirements of paragraph 46.4.3.3.



#### **46.4.3.3      *Portable Generating Equipment***

Where portable generating equipment or manual transfer is provided, sufficient storage capacity with alarm system will be provided to allow time for detection of pump station failure and transportation and connection of generating equipment. The use of special electrical connections and double throw switches are recommended for connecting portable generating equipment.

#### **46.4.4    Independent Utility Substations**

Where independent substations are used for emergency power, each separate substation and its associated transmission lines will be capable of starting and operating the pump station at its rated capacity.

### **47.    INSTRUCTIONS AND EQUIPMENT**

Wastewater pumping stations and portable equipment will be supplied with a complete set of operational instructions, including emergency procedures; maintenance schedules, tools and such spare parts as may be necessary for all equipment.

### **48.    FORCE MAINS**

#### **48.1    VELOCITY AND DIAMETER**

At design pumping rates, a cleansing velocity of at least 2 feet per second (0.60 m/s) will be maintained with only the smallest pump operating, unless special facilities are provided for cleaning the line at specified intervals or it can be shown that a flushing velocity of five (5) feet per second or greater will occur one or more times per day. The minimum force main diameter for raw wastewater will not be less than 4 inches (100 mm), unless justified, as with the use of grinder pumps.

#### **48.2    AIR AND VACUUM RELIEF VALVE**

An air relief valve suitable for use with wastewater will be placed at high points in the force main to prevent air locking. Vacuum relief valves may be necessary to relieve negative pressures on force mains. The force main configuration and head conditions will be evaluated as to the need for and placement of vacuum relief valves.



### **48.3 TERMINATION**

Force mains will enter the gravity sewer system at a point not more than 2 feet (600 mm) above the flow line of the receiving manhole.

### **48.4 PIPE AND DESIGN PRESSURE**

Pipe and joints will be equal to water main strength materials suitable for design conditions. All pipe will be identified in the technical specifications with appropriate ASTM, ANSI, or AWWA designations. All pipe and fittings will have a minimum working pressure rating of 150 pounds per square inch. The force main, reaction blocking, and station piping will be designed to withstand water hammer pressures and associated cyclic reversal of stresses that are expected with the cycling of wastewater lift stations. Surge protection chambers will be evaluated.

### **48.5 SPECIAL CONSTRUCTION**

Force main construction near streams or water works structures and at water main crossings will meet applicable provisions of Sections 36, 37, and 38 of Chapter 30.

### **48.6 DESIGN FRICTION LOSSES**

#### **48.6.1 Friction Coefficient**

Friction losses through force mains will be based on the Hazen and Williams formula or other acceptable methods. When the Hazen and Williams formula is used, the value for "C" will be 100 for unlined iron or steel pipe for design. For other smooth pipe materials such as PVC, polyethylene, lined ductile iron, etc., a higher "C" value not to exceed 120 may be allowed for design.

#### **48.6.2 Maximum Power Requirements**

When initially installed, force mains will have a significantly higher "C" factor. The effect of the higher "C" factor will be considered in calculating maximum power requirements and duty cycle time to prevent damage to the motor.





#### **48.7 IDENTIFICATION**

Where force mains are constructed of material which might cause the force main to be confused with potable water mains, the force main will be appropriately identified.

#### **48.8 LEAKAGE TESTING**

Leakage tests will be specified including testing methods and leakage limits. Force mains will be pressure tested at a minimum of 50 psi above the design working pressure.



## **CHAPTER 50**

### **WASTEWATER TREATMENT FACILITIES**

#### **51. PLANT LOCATION**

##### **51.1 GENERAL**

Items to be considered when selecting a plant site are listed in Chapter 10.

##### **51.2 FLOOD PROTECTION**

The treatment plant structures, electrical, and mechanical equipment will be protected from physical damage by the one hundred (100) year flood. Treatment plants will remain fully operational and accessible during the twenty-five (25) year flood. This requirement applies to new construction and to existing facilities undergoing major modification. Flood plain regulations of state and federal agencies will be considered.

#### **52. QUALITY OF EFFLUENT**

The required degree of wastewater treatment will be based on the effluent requirements and water quality standards established by the responsible state agency and/or appropriate federal regulations including discharge permit requirements.

#### **53. DESIGN**

##### **53.1 TYPE OF TREATMENT**

Items to be considered in selection of the appropriate type of treatment are presented in Chapter 10. The plant design will provide the necessary flexibility to perform satisfactorily within the expected range of waste characteristics and volumes.

##### **53.2 REQUIRED ENGINEERING DATA FOR NEW PROCESS AND APPLICATION EVALUATION**

The policy of the reviewing authority is to encourage rather than obstruct the development of any methods or equipment for treatment of wastewater. The lack of inclusion in these standards of some types of wastewater treatment processes or equipment will not be construed as precluding their use. The reviewing authority may approve other types of wastewater treatment processes and equipment under the condition that the operational reliability and effectiveness of



the process or device will have been demonstrated with a suitably-sized prototype unit operating at its design load conditions, to the extent required. To determine that such new processes and equipment or applications have a reasonable and substantial chance of success, the reviewing authority may require the following:

- a. Monitoring observations, including test results and engineering evaluations, demonstrating the efficiency of such processes.
- b. Detailed description of the test methods.
- c. Testing, including appropriately-composite samples, under various ranges of strength and flow rates (including diurnal variations) and waste temperatures over a sufficient length of time to demonstrate performance under climatic and other conditions which may be encountered in the area of the proposed installations.
- d. Other appropriate information.

The reviewing authority may require that appropriate testing be conducted and evaluations be made under the supervision of a competent process engineer other than those employed by the manufacturer or developer.

### **53.3 DESIGN PERIOD**

The design period will be clearly identified in the engineering report or facilities plan as required in Chapter 10.

### **53.4 DESIGN LOADS**

#### **53.4.1 Hydraulic Design**

##### ***53.4.1.1 Critical Flow Conditions***

Flow conditions critical to the design of the treatment plant are described in Chapter 10. Initial low flow conditions will be evaluated in the design to minimize operational problems with freezing, septicity, flow measurements and solids dropout. The design peak hourly flows will be considered in evaluating unit processes, pumping, piping, etc.

##### ***53.4.1.2 Treatment Plant Design Capacity***

The treatment plant design capacity will be as described in Chapter 10. The plant design flow selected will meet the appropriate effluent and water quality standards that are set forth in the discharge permit. The



design of treatment units that are not subject to peak hourly flow requirements will be based on the design average flow. For plants subject to high wet weather flows or overflow detention pump back flows, the design maximum day flows that the plant is to treat on a sustained basis will be specified.

#### **53.4.1.3 Flow Equalization**

Facilities for the equalization of flows and organic shock load will be considered at all plants, which are critically affected by surge loadings. The sizing of the flow equalization facilities will be based on data obtained herein and from Chapter 10.

#### **53.4.2 Organic Design**

Organic loadings for wastewater treatment plant design will be based on the information given in Chapter 10. The effects of septage flow, which may be accepted at the plant, will be given consideration and appropriate facilities will be included in the design.

#### **53.4.3 Shock Effects**

The shock effects of high concentrations and diurnal peaks for short periods of time on the treatment process, particularly for small treatment plants, will be considered.

### **53.5 CONDUITS**

All piping and channels will be designed to carry the maximum expected flows. The incoming sewer will be designed for unrestricted flow. Bottom corners of the channels will be filleted. Conduits will be designed to avoid creation of pockets and corners where solids can accumulate. Suitable gates or valves will be placed in channels to seal off unused sections, which might accumulate solids. The use of shear gates, stop plates or stop planks is permitted where they can be used in place of gate valves or sluice gates. Non-corrodible materials will be used for these control gates.

### **53.6 ARRANGEMENT OF UNITS**

Component parts of the plant will be arranged for greatest operating and maintenance convenience, flexibility, economy, continuity of maximum effluent quality, and ease of installation of future units.



### **53.7 FLOW DIVISION CONTROL**

Flow division control facilities will be provided as necessary to insure organic and hydraulic loading control to plant process units and will be designed for easy operator access, change, observation, and maintenance. The use of head boxes equipped with adjustable sharp-crested weirs or similar devices is recommended. The use of valves for flow splitting is not recommended. Appropriate flow measurement facilities will be incorporated in the flow division control design.

## **54. PLANT DETAILS**

### **54.1 INSTALLATION OF MECHANICAL EQUIPMENT**

The specifications will be so written that the installation and initial operation of major items of mechanical equipment will be inspected and approved by a representative of the manufacturer.

### **54.2 UNIT BYPASSES**

#### **54.2.1 Removal from Service**

Properly located and arranged bypass structures and piping will be provided so that each unit of the plant can be removed from service independently. The bypass design will facilitate plant operation during unit maintenance and emergency repair so as to minimize deterioration of effluent quality and insure rapid process recovery upon return to normal operational mode. Bypassing may be accomplished through the use of duplicate or multiple treatment units in any stage.

#### **54.2.2 Unit Bypass During Construction**

Unit bypassing during construction will be in accordance with the requirements in Chapter 12 paragraph 12.5.2(i) and Chapter 20, paragraph 20.15 and Section 21.

### **54.3 UNIT DEWATERING, FLOTATION PROTECTION, AND PLUGGING**

Means such as drains or sumps will be provided to completely dewater each unit to an appropriate point in the process. Due consideration will be given to the possible need for hydrostatic pressure relief devices to prevent flotation of structures. Pipes subject to plugging will be provided with means for mechanical cleaning or flushing.



#### 54.4 CONSTRUCTION MATERIALS

Materials will be selected that are appropriate under conditions of exposure to hydrogen sulfide and other corrosive gases, greases, oils, and other constituents frequently present in wastewater. This is particularly important in the selection of metals and paints. Contact between dissimilar materials will be avoided or other provisions made to minimize galvanic action.

#### 54.5 PAINTING

The use of paints containing lead or mercury will be avoided. In order to facilitate identification of piping, particularly in the large plants, it is suggested that the different lines be color-coded. The following color scheme is recommended for purposes of standardization.

- a. Raw biosolids line - *brown with black bands*
- b. Biosolids recirculation suction line - *brown with yellow bands*
- c. Biosolids draw off line - *brown with orange bands*
- d. Biosolids recirculation discharge line - *brown*
- e. Biosolids gas line - *orange (or red)*
- f. Natural gas line - *orange (or red) with black bands*
- g. Nonpotable water line - *blue with black bands*
- h. Potable water line - *blue*
- i. Chlorine line - *yellow*
- j. Sulfur Dioxide - *yellow with red bands*
- k. Sewage (wastewater) line - *gray*
- l. Compressed air line - *green*
- m. Water lines for heating digesters or buildings - *blue with a 6-inch (150 mm) red band spaced 30 inches (760 mm) apart*

The contents and direction of flow will be stenciled on the piping in a contrasting color.

#### 54.6 OPERATING EQUIPMENT

A complete outfit of tools, accessories, and spare parts necessary for the plant operator's use will be provided.

Readily accessible storage space and workbench facilities will be provided, and consideration will be given to provision of a garage for large equipment storage, maintenance, and repair.

#### 54.7 EROSION CONTROL DURING CONSTRUCTION

Effective site erosion control will be provided during construction.



#### **54.8 GRADING AND LANDSCAPING**

Upon completion of the plant, the ground will be graded and sodded or seeded. All-weather walkways will be provided for access to all units. Where possible, steep slopes will be avoided to prevent erosion. Surface water will not be permitted to drain into any unit. Particular care will be taken to protect trickling filter beds, biosolids beds, and intermittent sand filters from storm water runoff. Provision will be made for landscaping, particularly when a plant will be located near residential areas.

### **55. PLANT OUTFALLS**

#### **55.1 DISCHARGE IMPACT CONTROL**

The outfall sewer will be designed to discharge to the receiving stream or permitted land application area(s) in a manner acceptable to the reviewing authority. Consideration will be given in each case to the following:

- a. Preference for free fall or submerged discharge at the site selected;
- b. Utilization of cascade aeration of effluent discharge to increase dissolved oxygen; and
- c. Limited or complete across-stream dispersion as needed to protect aquatic life movement and growth in the immediate reaches of the receiving stream.
- d. Uniform distribution to land application area(s), perimeter berms, perimeter fencing, etc.

#### **55.2 PROTECTION AND MAINTENANCE**

The outfall sewer will be so constructed and protected against the effects of floodwater, tide, ice, or other hazards as to reasonably insure its structural stability and freedom from stoppage. A manhole will be provided at the shore end of all gravity sewers extended into the receiving waters. Hazards to navigation will be considered in designing outfall sewers.

#### **55.3 SAMPLING PROVISIONS**

All outfalls will be designed so that a sample of the effluent can be obtained at a point after the final treatment process and before discharge to or mixing with the receiving waters or discharge to land application area(s).



## **56. ESSENTIAL FACILITIES**

### **56.1 EMERGENCY POWER FACILITIES**

#### **56.1.1 General**

All plants will be provided with an alternate source of electric power or pumping capability to allow continuity of operation during power failures, except as noted below. Refer to Chapter 40 paragraph 46.4 for design details. Methods of providing alternate sources include:

- a. The connection of at least two independent power sources such as substations. A power line from each substation is recommended, and will be required unless documentation is received and approved by the reviewing authority verifying that a duplicate line is not necessary;
- b. Portable or in-place internal combustion engine equipment which will generate electrical or mechanical energy; and
- c. Portable pumping equipment when only emergency pumping is required.

#### **56.1.2 Power for Aeration**

Standby generating capacity normally is not required for aeration equipment used in the activated biosolids process. In cases where a history of long-term (4 hours or more) power outages has occurred, auxiliary power for minimum aeration of the activated biosolid will be required. Full power generating capacity may be required by the reviewing authority for waste discharges to certain critical stream segments, areas of increased ground and surface water vulnerability

#### **56.1.3 Power for Disinfection**

Continuous disinfection, where required, will be provided during all power outages. Continuous dechlorination is required for those systems that dechlorinate.

### **56.2 WATER SUPPLY**

#### **56.2.1 General**

An adequate supply of potable water under pressure will be provided for use in the laboratory and for general cleanliness around the plant. No piping or other connections will exist in any part of the treatment plant, which, under any





conditions, might cause the contamination of a potable water supply. The chemical quality will be checked for suitability for its intended uses such as in heat exchangers, chlorinators, etc.

### **56.2.2 Direct Connections**

Potable water from a municipal or separate supply may be used directly at points above grade for the following hot and cold supplies:

- a. Lavatory.
- b. Water closet.
- c. Laboratory sink (with vacuum breaker).
- d. Shower.
- e. Drinking fountain.
- f. Eye wash fountain.
- g. Safety shower.

Hot water for any of the above units will not be taken directly from a boiler used for supplying hot water to a biosolids heat exchanger or digester heating unit.

### **56.2.3 Indirect Connections**

Where a potable water supply is to be used for any purpose in a plant other than those listed in paragraph 56.2.2, a break tank, pressure pump, and pressure tank will be provided. Water will be discharged to the tank through an air gap at least 6 inches (150 mm) above the maximum flood line or the spill line of the tank, whichever is higher.

A sign will be permanently posted at every hose bib, faucet, hydrant, or sill cock located on the water system beyond the break tank to indicate that the water is not safe for drinking.

### **56.2.4 Separate Potable Water Supply**

Where it is not possible to provide potable water from a public water supply, a separate well may be provided. Location and construction of the well will comply with requirements of the governing state or local regulations. Requirements governing the use of the supply are those contained in paragraphs 56.2.2 and 56.2.3.



### **56.2.5 Separate Non-Potable Water Supply**

Where a separate non-potable water supply is to be provided, a break tank will not be necessary, but all system outlets will be posted with a permanent sign indicating the water is not safe for drinking.

## **56.3 SANITARY FACILITIES**

Toilet, shower, lavatory, and locker facilities will be provided in sufficient numbers and convenient locations to serve the expected plant personnel and when constructed, will comply with the American Disabilities Act, if applicable.

## **56.4 FLOOR SLOPE**

Floor surfaces will be sloped adequately to a point of drainage.

## **56.5 STAIRWAYS**

Stairways will be installed in lieu of ladders for access to units requiring routine inspection and maintenance, such as digesters, trickling filters, aeration tanks, clarifiers, tertiary filters, etc. Spiral or winding stairs are permitted only for secondary access where dual means of egress are provided.

Stairways will have slopes between 30 and 40 degrees from the horizontal to facilitate carrying samples, tools, etc. Each tread and riser will be of uniform dimension in each flight. Minimum tread run will not be less than 9 inches (230 mm). The sum of the tread run and riser will not be less than 17 inches (430 mm) nor more than 18 inches (460 mm). A flight of stairs will consist of not more than a 12-foot (3.7 m) continuous rise without a platform.

## **56.6 FLOW MEASUREMENT**

### **56.6.1 Location**

Flow measurement facilities will be provided to measure the following flows:

- a. Plant influent or effluent flow;
- b. Plant influent flow: If influent flow is significantly different from effluent flow, both will be measured. This will apply for installations such as lagoons, sequencing batch reactors, and plants with excess flow storage or flow equalization;



- c. Excess flow treatment facility discharges;
- d. Other flows required to be monitored under the provisions of the discharge permit; and
- e. Other flows such as return activated biosolids, waste activated biosolids, recirculation, and recycle required for plant operational control.

#### **56.6.2 Facilities**

Indicating, totalizing, and recording flow measurement devices will be provided for all mechanical plants. Flow measurement facilities for lagoon systems will not be less than elapsed time meters used in conjunction with pumping rate tests or will be calibrated weirs or other flow metering device subject to regulating approval. All flow measurement equipment will be sized to function effectively over the full range of flows expected and will be protected against freezing.

#### **56.6.3 Hydraulic Conditions**

Flow measurement equipment including approach and discharge conduit configuration and critical control elevations will be designed to ensure that the required hydraulic conditions necessary for accurate measurement are provided. Conditions that will be avoided include turbulence, eddy currents, air entrainment, etc., that upset the normal hydraulic conditions that are necessary for accurate flow measurement.

### **56.7 SAMPLING EQUIPMENT**

Effluent composite sampling equipment will be provided at all mechanical plants with a design average flow of 0.1 mgd (379 m<sup>3</sup>/day) or greater and at other facilities where necessary to meet discharge permit monitoring requirements. Composite sampling equipment will also be provided as needed for influent sampling and for monitoring plant operations. The influent sampling point will be located prior to any process return flows.

## **57. SAFETY**

### **57.1 GENERAL**

Adequate provision will be made to effectively protect plant personnel and visitors from hazards. The following will be provided to fulfill the particular needs of each plant.



- a. Enclosure of the plant site with a fence and signs designed to discourage the entrance of unauthorized persons and animals;
- b. Hand rails and guards around tanks, trenches, pits, stairwells, and other hazardous structures with the tops of walls less than 42 inches (1.0 m) above the surrounding ground level;
- c. Gratings over appropriate areas of treatment units where access for maintenance is required;
- d. First aid equipment;
- e. "No Smoking" signs in hazardous areas;
- f. Protective clothing and equipment, such as self-contained breathing apparatus, gas detection equipment, goggles, gloves, hard hats, safety harnesses, etc.;
- g. Portable blower and sufficient hose;
- h. Portable lighting equipment complying with the National Electrical Code requirements;
- i. Gas detectors certified for use in Class I, Group D, Division 1 locations;
- j. Appropriately-placed warning signs for slippery areas, non-potable water fixtures, low head clearance areas, open service manholes, hazardous chemical storage areas, flammable fuel storage areas, etc.;
- k. Adequate ventilation in pump station areas in accordance with Chapter 40, Section 42.7;
- l. Provisions for local lockout on stop motor controls;
- m. Provisions for confined space entry and laboratory safety in accordance with OSHA and regulatory agency requirements; and
- n. Adequate vector control.

## **57.2 HAZARDOUS CHEMICAL HANDLING**

### **57.2.1 Containment Materials**

The materials utilized for storage, piping, valves, pumping, metering, splash guards, etc., will be specially selected considering the physical and chemical characteristics of each hazardous or corrosive chemical.

### **57.2.2 Secondary Containment**

Chemical storage areas will be enclosed in dikes or curbs, which will contain the stored volume until it can be safely transferred to alternate storage or released to the wastewater at controlled rates, which will not damage facilities, inhibit the treatment processes, or contribute to surface or ground water pollution. Liquid



polymer will be similarly contained to reduce areas with slippery floors, especially to protect travel ways. Non-slip floor surfaces are desirable in polymer-handling areas.

### **57.2.3 Liquefied Gas Chemicals**

Properly designed isolated areas will be provided for storage and handling of chlorine and sulfur dioxide and other hazardous gases. Gas detection kits, alarms, controls, safety devices, and emergency repair kits will also be provided.

### **57.2.4 Splash Guards**

All pumps or feeders for hazardous or corrosive chemicals will have guards, which will effectively prevent spray of chemicals into space occupied by personnel. The splashguards are in addition to guards to prevent injury from moving or rotating machinery parts.

### **57.2.5 Piping, Labeling, Coupling Guards, Location**

All piping containing or transporting corrosive or hazardous chemicals will be identified with labels every 10 feet (3 m) and with at least two labels in each room, closet, or pipe chase. Color-coding may also be used, but is not an adequate substitute for labeling.

All connections (flanged or other type), except those adjacent to storage or feeder areas, will have guards which will direct any leakage away from space occupied by personnel. Pipes containing hazardous or corrosive chemicals will not be located above shoulder level except where continuous drip collection trays and coupling guards will eliminate chemical spray or dripping onto personnel.

### **57.2.6 Protective Clothing and Equipment**

The following items of protective clothing or equipment will be available and utilized for all operations or procedures where their use will minimize injury hazard to personnel:

- a. Self-contained breathing apparatus recommended for protection against chlorine.
- b. Chemical worker's goggles or other suitable goggles (safety glasses are insufficient).



## CHAPTER 60

### SCREENING, GRIT REMOVAL, AND FLOW EQUALIZATION

#### 61. SCREENING DEVICES

104.

##### 61.1 COARSE SCREENS

Protection for pumps and other equipment will be provided by trash racks, coarse bar racks, or coarse screens, and fine screens. Bar screens will have a minimum width of 3/8 inches and a maximum width of 1 ½ inches.

##### 61.2 DESIGN AND INSTALLATION

###### 61.2.1 Bar Spacing

Clear openings between bars will be no less than one inch (25 mm) for manually cleaned screens. Clear openings for mechanically cleaned screens may be smaller, but no less than ¼-inch to prevent excessive capture of organics. If less than ¼-inch openings are desired, special systems for washing organics back into the flow stream are required. Maximum clear openings will be 1¾ inches (45 mm).

###### 61.2.2 Slope and Velocity

Manually cleaned screens will be placed on a slope of 30 to 45 degrees from the horizontal.

At design average flow conditions, approach velocities will be no less than 1.25 feet per second (0.4 m/s), to prevent settling; and no greater than 3.0 fps (0.9 m/s) to prevent forcing material through openings.

###### 61.2.3 Channels

Dual channels will be provided and equipped with the necessary gates to isolate flow from any screening unit. Provisions will also be made to facilitate dewatering each unit. The channel preceding and following the screen will be shaped to eliminate stranding and settling of solids.



#### **61.2.4 Auxiliary Screens**

Where a single mechanically cleaned screen is used, an auxiliary manually cleaned screen will be provided. Where two or more mechanically cleaned screens are used, the design will provide for taking any unit out of service without sacrificing the capability to handle the design peak instantaneous flows.

#### **61.2.5 Invert**

The screen channel invert will be 3 to 6 inches (75-150 mm) below the invert of the incoming sewer.

#### **61.2.6 Flow Distribution**

Entrance channels will be designed to provide equal and uniform distribution of the flow to the screens.

#### **61.2.7 Backwater Effect on Flow Metering**

The effect of changes in backwater elevation, due to intermittent cleaning of screens, will be considered in locations of flow measurement equipment, in particular, submergence of flumes beyond that recommended by the flume manufacturer is to be avoided. Head losses at no less than 50 percent blockage are to be provided by the screen manufacturer or estimated by the screen design engineer to determine backwater effects.

#### **61.2.8 Freeze Protection**

In areas where freezing moisture can result in impairment of the screen or screenings handling equipment, freeze protection will be provided.

#### **61.2.9 Screenings Removal and Disposal**

A convenient and adequate means for removing screening will be provided. Facilities will be provided for handling, storage, and disposal of screenings in a manner acceptable to prevent nuisance conditions as determined by the regulatory agency. Consideration will be given to providing screenings washing and compacting equipment to reduce the quantity of organics in the screenings and the quantity of screenings requiring disposal. Use of screenings compaction equipment without washing is not recommended.



Manually cleaned screening facilities will include an accessible platform from which the operator may rake screening easily and safely. Suitable drainage facilities will be provided for both the platform and the storage area.

### **61.3 ACCESS AND VENTILATION**

Screens located in pits more than 4 feet (1.2 m) deep will be provided with stairway access. Access ladders are acceptable for pits less than 4 feet (1.2 m) deep, in lieu of stairways.

Screening devices, installed in a building where other equipment or offices are located, will be isolated from the rest of the building, provided with separate outside entrances, and a separate and independent fresh air supply.

Fresh air will be forced into enclosed screening device areas or into open pits more than 4 feet deep (1.2 m). Dampers will not be used on exhaust or fresh air ducts and fine screens or other obstructions will be avoided to prevent clogging. Where continuous ventilations causes excessive heat loss, intermittent ventilation of at least 30 complete air changes per hour will be provided when personnel enter the area. The air change requirements will be based on 100 percent fresh air.

Switches for operation of ventilation equipment will be marked and located conveniently. All intermittently operated ventilation equipment will be interconnected with the respective pit lighting system. The fan wheel will be fabricated from non-sparking material. Explosion proof gas detectors will be provided in accordance with Chapter 50, Section 57.

### **61.4 SAFETY AND SHIELDS**

#### **61.4.1 Railings and Gratings**

Manually cleaned screen channels will be protected by guard railings and deck gratings, with adequate provisions for removal or opening to facilitate raking.

Mechanically cleaned screen channels will be protected by guard railings and deck gratings. Consideration will also be given to temporary access arrangements to facilitate maintenance and repair.





#### **61.4.2 Mechanical Devices**

Mechanical screening equipment will have adequate removable enclosures to protect personnel against accidental contact with moving parts and to prevent dripping in multi-level installations.

A positive means of locking out each mechanical device and temporary access for use during maintenance will be provided.

#### **61.4.3 Drainage**

Floor design and drainage will be provided to prevent slippery areas.

#### **61.4.4 Lighting**

Suitable lighting will be provided in all work and access areas.

### **61.5 ELECTRICAL EQUIPMENT AND CONTROL SYSTEMS**

#### **61.5.1 Timing Devices**

All mechanical units which are operated by timing devices will be provided with auxiliary controls which will set the cleaning mechanism in operation at a preset high water elevation. If the cleaning mechanism fails to lower the high water, a warning will be signaled.

#### **61.5.2 Electrical Equipment, Fixtures and Controls**

Electrical equipment, fixtures and controls in the screening area where hazardous gasses may accumulate will meet the requirements of the National Electrical Code for Class I, Group D, Division 1 locations.

#### **61.5.3 Manual Override**

Automatic controls will be supplemented by a manual override.

## **62. COMMINUTORS**

### **62.1 GENERAL**

Provisions for access, ventilation, shields, and safety will be in accordance with Sections 61.3, 61.4, and 61.5.



## **62.2 WHEN USED**

Comminutors may be used in combination with screening devices to protect equipment where stringy substance accumulation on downstream equipment will not be a substantial problem.

## **62.3 DESIGN CONSIDERATIONS**

### **62.3.1 Location**

Comminutors will be located downstream of grit removal equipment and be protected by a coarse screening device. Comminutors not preceded by grit removal equipment will be protected by a 6.0-inch (150 mm) deep gravel trap.

### **62.3.2 Size**

Comminutor capacity will be adequate to handle design peak hourly flow.

### **62.3.3 Installation**

A screened bypass channel will be provided. The use of the bypass channel will be automatic for all comminutor failures.

Gates will be provided in accordance with paragraphs 61.2.3 and 61.2.4.

### **62.3.4 Servicing**

Provisions will be made to facilitate servicing units in place and removing units from their location for servicing.

### **62.3.5 Electrical Controls and Motors**

Electrical equipment in comminutor chambers where hazardous gases may accumulate, will meet the requirements of the National Electrical Code for Class I, Group D, Division 1 locations. Motors will be protected against accidental submergence.

## **63. GRIT REMOVAL FACILITIES**

### **63.1 WHEN REQUIRED**

Grit removal facilities are highly recommended for wastewater treatment plants.



## **63.2 LOCATION**

### **63.2.1 General**

Grit removal facilities will be located ahead of pumps and comminuting devices. Coarse bar racks will be placed ahead of grit removal facilities.

### **63.2.2 Housed Facilities**

#### **63.2.2.1 Ventilation**

Refer to 61.1.3. Fresh air will be introduced continuously at a rate of at least 12 air changes per hour, or intermittently with a rate of at least 30 air changes per hour. Odor control facilities may also be warranted.

#### **63.2.2.2 Access**

Adequate stairway access to above or below grade facilities will be provided.

#### **63.2.2.3 Electrical**

All electrical work in enclosed grit removal areas where hazardous gases may accumulate will meet the requirement of the National Electric Code for Class I, Group D, Division 1 locations. Explosion proof gas detectors will be provided in accordance with Section 57.

### **63.2.3 Outside Facilities**

Grit removal facilities located outside will be protected from freezing.

## **63.3 TYPE AND NUMBER OF UNITS**

A single manually cleaned or mechanically cleaned grit chamber with bypass is acceptable for wastewater treatment plants with design flows of less than 1 mgd. Minimum facilities for larger plants with flows greater than 1 mgd will be at least one mechanically cleaned unit with a bypass.



## **63.4 DESIGN FACTORS**

### **63.4.1 General**

The design effectiveness of a grit removal system will be commensurate with the requirements of the subsequent process units.

### **63.4.2 Inlet**

Inlet turbulence will be minimized in channel type units.

### **63.4.3 Velocity and Detention**

Channel-type chambers will be designed to control velocities during normal variations in flow as close as possible to one foot per second (0.30 m/s). The detention period will be based on the size of particle to be removed. All aerated grit removal facilities will be provided with adequate control devices to regulate air supply and agitation.

### **63.4.4 Aerated Grit Chambers**

Aerated grit chambers will be designed for a detention time in the tank of no less than 3 minutes at design peak hourly flows. For horizontal tanks, length to width ratio will not be less than 3:1, and width to depth ratio not greater than 0.8. Floor slopes in aerated grit chambers will not be less than 30 degrees. Aerated grit chambers will have air rate adjustable in the range of 3 to 8 cubic feet per minute per foot (4.7 to 12.4 L/s/m) of tank length.

### **63.4.5 Vortex Grit Chambers**

Vortex grit chambers will be designed as required by the equipment manufacturer. Particular attention will be provided to inlet channel length to width ratio, which will be no less than 4:1 and preferably 7:1.

### **63.4.6 Grit Pumping**

Where possible, grit pumps will be flooded suction with short suction lines. Adequate cleanouts for removing obstructions before and after the pumps are required. A minimum of 4 fps is required in grit pump discharge lines. Use of top-mounted pumps and air lift pumps is discouraged for plants receiving heavy grit loading.



#### **63.4.7 Grit Washing and Classification**

Use of grit washing and classification equipment is required for all grit removal facilities.

#### **63.4.8 Dewatering**

Provision will be made for isolating and dewatering each unit. The design will provide for complete draining and cleaning by means of a sloped bottom equipped with a drain sump.

#### **63.4.9 Water**

An adequate supply of water under pressure will be provided for cleanup.

### **64. FLOW EQUALIZATION**

#### **64.1 GENERAL**

Use of flow equalization will be considered where significant variations in organic and hydraulic loading could be expected.

#### **64.2 LOCATION**

Equalization basins will be located downstream of pretreatment facilities such as bar screens, comminutors, and grit chambers.

#### **64.3 TYPE**

Flow equalization can be provided by using separate basins or on-line treatment units, such as aeration tanks. Equalization basin may be designed as either in-line or side-line units. Unused treatment units, such as sedimentation or aeration tanks, may be utilized as equalization basins during the early period of design life. It is recommended that all equilibrium basins have a method to regulate flow from the basin.

#### **64.4 SIZE**

Equalization basin capacity will be sufficient to effectively reduce expected flow and load variations to the extent deemed to be economically advantageous. With a diurnal flow pattern, the volume required to achieve the desired degree of



equalization can be determined from a cumulative flow plot over a representative 24-hour period.

## **64.5 OPERATION**

### **64.5.1 Mixing**

Aeration or mechanical equipment will be provided to maintain adequate mixing. Corner fillets and hopper bottoms with draw-offs will be provided to alleviate the accumulation of biosolids and grit.

### **64.5.2 Aeration**

Aeration equipment will be sufficient to maintain a minimum of 1.0 mg/L of dissolved oxygen in the mixed basin contents at all times. Air supply rates will be a minimum of 1.25 cfm/1000 gallons (0.15 L/s/m<sup>3</sup>) of storage capacity. The air supply will be isolated from other treatment plant aeration requirements to facilitate process aeration control, although process air supply equipment may be utilized as a source of standby aeration.

### **64.5.3 Controls**

Inlets and outlets for all basin compartments will be suitably equipped with accessible external valves, stop plates, weirs, or other devices to permit flow control and the removal of an individual unit from service. Facilities will also be provided to measure and indicate liquid levels and flow rates.

## **64.6 ELECTRICAL**

All electrical work in housed equalization basins, where hazardous concentrations of flammable gases or vapors may accumulate, will meet the requirements of the National Electrical Code for Class I, Group D, Division 1 locations.

## **64.7 ACCESS**

Suitable access will be provided to facilitate cleaning and the maintenance of equipment.

**CHAPTER 70****SETTLING****71. GENERAL****71.1 NUMBER OF UNITS**

Multiple units capable of independent operation are desirable and will be provided in all plants where design average flows exceed 100,000 gallons/day (379 m<sup>3</sup>/d). Plants not having multiple units will include other provisions to assure continuity of treatment during periods when the unit is taken off line for maintenance.

**71.2 FLOW DISTRIBUTION**

Effective flow splitting devices, preferably overflow weirs, and control appurtenances (i.e. gates, splitter boxes, etc.) will be provided to permit proper proportioning of flow and solids loading to each unit, throughout the expected range of flows.

**72. DESIGN CONSIDERATIONS****72.1 DIMENSIONS**

The minimum length of flow from inlet to outlet will be 10 feet (3 m) unless special provisions are made to prevent short-circuiting. The vertical side water depths will be designed to provide an adequate separation zone between the biosolids blanket and the overflow weirs. The side water depths will not be less than the following values:

Type of Settling Tank	Minimum Side Water Depth	
	ft	(m)
Primary	12	3.6
Secondary tank following Activated biosolids process*	16.3	5.0
Secondary tank following Fixed film reactor	12	3.6



Greater side water depths are recommended for secondary clarifiers in excess of 4,000 square feet (372 m<sup>2</sup>) surface area (equivalent to 70 feet (21 m) diameter) and for nitrification plants. Less than 12 feet (3.7 m) side water depths may be permitted for package plants with a design average flow less than 25,000 gallons per day (95 m<sup>3</sup>/d), if justified based on successful operating experience.

## 72.2 SURFACE OVERFLOW RATES

### 72.2.1 Primary Settling Tanks

Primary settling tanks sizing should reflect the degree of solids removal needed and the need to avoid septic conditions during low flow periods. Sizing will be calculated for both design average and design peak hourly flow conditions, and the larger surface area determined will be used. The following surface overflow rates should not be exceeded in the design:

Primary Settling Tank Surface Overflow Rates

Process Type	Average Flow		Peak Hourly Flow	
	gpd/ft <sup>2</sup>	(m <sup>3</sup> /m <sup>2</sup> d)	gpd/ft <sup>2</sup>	(m <sup>3</sup> /m <sup>2</sup> d)
Fixed Film	1,000	(41)	1,500-3,000	(60-120)
Waste activated biosolids	700	(28)	1,200	(49)

### 72.2.2 Intermediate Settling Tanks

Surface overflow rates for intermediate settling tanks following series units of fixed film reactor processes will not exceed 1,500 gallons per day per square foot (61 m<sup>3</sup>/m<sup>2</sup>d) based on design peak hourly flow.

### 72.2.3 Final Settling Tanks

Settling tests will be conducted wherever a pilot study of biological treatment is warranted by unusual waste characteristics, treatment requirements, or where proposed loadings go beyond the limits set forth in this Section.

### 72.2.4 Final Settling Tanks – Fixed Film Biological Reactors

Surface overflow rates for settling tanks following trickling filters will not exceed 1,200 gallons per day per square foot (49 m<sup>3</sup>/m<sup>2</sup>d) based on design peak hourly flow.



**72.2.4.1 Final Settling Tanks – Activated Biosolids**

To perform properly while producing a concentrated return flow, activated biosolids settling tanks will be designed to meet thickening as well as solids separation requirements. Since the rate of re-circulation of return biosolids from the final settling tanks to the aeration for re-aeration tanks is quite high in activated biosolids processes, surface overflow rate and weir overflow rate should be adjusted for the various processes to minimize the problems with biosolids loadings, density currents, inlet hydraulic turbulence, and occasional poor biosolids settle-ability. The size of the settling tank will be based on the larger surface area determined for surface overflow rate and solids loading rate. The following design criteria will be used:

Treatment Process	Surface Overflow Rate at Design Peak Hourly Flow*	Peak Solids Loading Rate**
	gpd/ft <sup>2</sup> (m <sup>3</sup> /m <sup>2</sup> d)	lb/day/ft <sup>2</sup> (kg/d/m <sup>2</sup> )
Conventional, Step Aeration, Complete Mix, Contact Stabilization, Carbonaceous Stage of Separate, Stage Nitrification	1,200** (49)	50 (245)
Extended Aeration Single Stage Nitrification	1,000 (41)	35 (171)

\* Based on influent flow only.

\*\* Plants needing to meet 20 mg/l suspended solids should reduce surface overflow rate to 1,000 gallons per day per square foot (41 m<sup>3</sup>/m<sup>2</sup>d).



### **72.3 INLET STRUCTURES**

Inlets will be designed to dissipate the inlet velocity, to distribute the flow equally both horizontally and vertically and to prevent short-circuiting. Flocculating inlet wells will be provided for final settling tanks in activated biosolids processes. Channels will be designed to maintain a velocity of at least one foot per second (0.3 m/s) at one-half of the design average flow. Corner pockets and dead ends will be eliminated and corner fillets or channeling will be used where necessary. Provisions will be made for elimination or removal of floating materials in inlet structures.

### **72.4 WEIRS/TROUGHS**

#### **72.4.1 General**

Overflow weirs will be readily adjustable over the life of the structure to correct for differential settlement of the tank. Provisions will be provided for access and/or cleaning of weirs and troughs.

#### **72.4.2 Location**

Overflow weirs will be located to optimize actual hydraulic detention time, and minimize short-circuiting. Peripheral weirs will be placed at least one foot from the wall.

#### **72.4.3 Design Rates**

V-notch weirs will be designed to handle all ranges of flows. Top of weir will be a minimum of  $\frac{3}{4}$ " above the peak hour flow water surface grade line.

#### **72.4.4 Weir Troughs**

Weir troughs will be designed to prevent submergence at design peak hourly flow, and to maintain a velocity of at least one foot per second (0.3 m/s) at one-half design average flow.

### **72.5 STAMFORD BAFFLES**

Wall mounted baffles will be provided for final settling tanks in activated biosolids processes to prevent solids washout by high flows.



## **72.6 UNIT DEWATERING**

Provisions for unit dewatering will conform to the provisions outlined in paragraph 54.3. The bypass design will also provide for distribution of the plant flow to the remaining units.

## **72.7 FREEBOARD**

Walls of settling tanks will extend at least 6 inches (150 mm) above the surrounding ground surface and will provide not less than 12 inches (300 mm) freeboard. Additional freeboard or the use of windscreens is recommended where larger settling tanks are subject to high velocity winds that would cause tank surface waves and inhibit effective scum removal.

# **73. BIOSOLIDS AND SCUM REMOVAL**

## **73.1 SCUM REMOVAL**

Full surface mechanical scum collection and removal facilities, including baffling, will be provided for all settling tanks. The unusual characteristics of scum, which may adversely affect pumping, piping, biosolids handling and disposal, will be recognized in design. Provisions may be made for the discharge of scum with the biosolids; however, other special provisions for disposal may be necessary.

## **73.2 FOAM REMOVAL**

Provisions for foam removal will be provided for all tanks handling waste activated processes.

## **73.3 BIOSOLIDS REMOVAL**

Mechanical biosolids collection and withdrawal facilities will be designed to assure removal of the biosolids. Each settling tank will have its own biosolids withdrawal lines to insure adequate control of biosolids wasting rate for each tank.

### **73.3.1 Biosolids Hopper**

The minimum slope of the sidewalls will be 1.7 vertical to 1 horizontal. Extra depth biosolids hoppers for biosolids thickening are not acceptable.



### **73.3.2 Cross-Collectors**

Cross-collectors serving one or more settling tanks may be useful in place of multiple biosolids hoppers.

### **73.3.3 Biosolids Removal Pipeline**

Each hopper will have an individually valved biosolids withdrawal line at least six inches (150 mm) in diameter. Clearance between the end of the withdrawal line and the hopper walls will be sufficient to prevent “bridging” of the biosolids. Adequate provisions will be made for rodding or back-flushing individual pipe runs. Piping will be provided to return biosolids for further processing. Provisions will be provided for sampling of the waste biosolids.

### **73.3.4 Biosolids Removal Control**

Separate settling tank biosolids lines may drain to a common biosolids well.

Biosolids wells equipped with telescoping valves or other appropriate equipment will be provided for viewing, sampling, and controlling the rate of biosolids withdrawal. A means of measuring the biosolids removal rate will be provided. Air-lift type of biosolids removal will not be approved for removal of primary biosolids.

## **74. PROTECTIVE AND SERVICE FACILITIES**

### **74.1 OPERATOR PROTECTION**

All settling tanks will be equipped to enhance safety for operators. Such features will appropriately include machinery covers, lifelines, stairways, walkways, handrails, and slip resistant surfaces.

### **74.2 MECHANICAL MAINTENANCE ACCESS**

The design will provide for convenient and safe access to routine maintenance items such as gearboxes, scum removal mechanisms, baffles, weirs, inlet stilling baffle areas, and effluence channels.



### **74.3 ELECTRICAL EQUIPMENT, FIXTURES AND CONTROLS**

Electrical equipment, fixtures and controls in and around settling basins and scum tanks will meet the requirements of the National Electrical Code for Class 1, Group D, Division 1 locations.

The fixtures and controls will be located so as to provide convenient and safe access for operation and maintenance. Adequate area lighting will be provided.



## CHAPTER 80

### BIOSOLIDS PROCESSING, STORAGE, AND DISPOSAL

#### 81. GENERAL

Facilities for processing biosolids may be required at mechanical wastewater treatment plants. Handling equipment will be capable of processing biosolids to a form suitable for ultimate disposal unless provisions acceptable to the regulatory agency are made for processing or disposal of the biosolids at an alternate location.

The reviewing authority will be contacted if biosolids unit processes not described in this Chapter are being considered or are necessary to meet state or federal biosolids treatment and disposal requirements.

#### 82. PROCESS SELECTION

The selection of biosolids handling unit processes will be based upon at least the following considerations:

- a. Local land use.
- b. System energy requirements.
- c. Cost effectiveness of biosolids thickening and dewatering.
- d. Equipment complexity and staffing requirements.
- e. Adverse effects of heavy metals and other biosolids components upon the unit processes.
- f. Biosolids digestion or stabilization requirements, including appropriate pathogen and vector attraction reduction.
- g. Side stream or return flow treatment requirements (e.g., digester or biosolids storage facilities supernatant, dewatering unit filtrate, wet oxidation return flows).
- h. Biosolids storage requirements; Methods of ultimate disposal.
- i. Back-up techniques of biosolids handling and disposal.

#### 83. BIOSOLIDS THICKENERS

##### 83.1 DESIGN CONSIDERATIONS

Biosolids thickeners to reduce the volume of biosolids will be considered. The design of thickeners (gravity, dissolved-air flotation, gravity belt thickeners, centrifuge, and others) will consider the type and concentration of biosolids, the biosolids stabilization processes, storage requirements, the method of ultimate



biosolids disposal, chemical needs, and the cost of operation. The use of gravity thickening tanks for unstabilized biosolids is not recommended because of problems due to septicity unless provisions are made for adequate control of process operational problems and odors at the gravity thickener and any following unit processes. Particular attention will be given to the pumping and piping of the concentrated biosolids and possible onset of anaerobic conditions.

## **83.2 PROTOTYPE STUDIES**

Process selection and unit process design parameters will be based on prototype studies. The reviewing authority will require such studies where the sizing of other plant units is dependent on performance of the thickeners. Refer to Chapter 50, paragraph 53.2 for any new process determination.

## **84. ANAEROBIC BIOSOLIDS DIGESTION**

### **84.1 GENERAL**

#### **84.1.1 Multiple Units**

Multiple units or alternate methods of biosolids processing will be provided. Facilities for biosolids storage and supernatant separation in an additional unit may be required, depending on raw biosolids concentration and disposal methods for biosolids and supernatant.

#### **84.1.2 Depth**

If process design provides for supernatant withdrawal, the proportion of depth to diameter will be such as to allow for the formation of a reasonable depth of supernatant liquor. A minimum side water depth of 20 feet (6.1 m) is recommended.

#### **84.1.3 Design Maintenance Provisions**

To facilitate emptying, cleaning, and maintenance, the following features are desirable:

##### **84.1.3.1 Slope**

The tank bottom will slope to drain toward the withdrawal pipe. For tanks equipped with a suction mechanism for biosolids withdrawal, a bottom slope not less than 1 to 12 is recommended. Where the



biosolid is to be removed by gravity alone, 1 to 4 slope is recommended.

#### **84.1.3.2 Access Manholes**

At least 2 access manholes not less than 30 inches (750 mm) in diameter will be provided in the top of the tank in addition to the gas dome. There will be stairways to reach the access manholes.

A separate sidewall manhole will be provided that is large enough to permit the use of mechanical equipment to remove grit and sand. The sidewall access manhole will be low enough to facilitate heavy equipment handling and may be buried in the earthen bank insulation.

#### **84.1.3.3 Safety**

Non-sparking tools, rubber-soled shoes, safety harness, gas detectors for flammable and toxic gases, and at least two self-contained breathing units will be provided for emergency use. Refer to other safety items as appropriate in Chapter 50, Section 57.

#### **84.1.4 Toxic Materials**

If the anaerobic digestion process is proposed, the basis of design will be supported by wastewater analyses to determine the presence of undesirable materials, such as high concentrations of sulfates and inhibitory concentrations of heavy metals.

### **84.2 BIOSOLIDS INLETS, OUTLETS, RECIRCULATION, AND HIGH LEVEL OVERFLOW**

#### **84.2.1 Multiple Inlets and Draw-Offs**

Multiple biosolids inlets and draw-offs and, where used, multiple recirculation suction and discharge points to facilitate flexible operation and effective mixing of the digester contents will be provided unless adequate mixing facilities are provided within the digester.

#### **84.2.2 Inlet Configurations**

One inlet will discharge above the liquid level and be located at approximately the center of the tank to assist in scum breakup. The second inlet will be





opposite to the suction line at approximately the 2/3-diameter point across the digester.

#### **84.2.3 Inlet Discharge Location**

Raw biosolids inlet discharge points will be so located as to minimize short-circuiting to the digested biosolids or supernatant draw-offs.

#### **84.2.4 Biosolids Withdrawal**

Biosolids withdrawal to disposal will be from the bottom of the tank. The bottom withdrawal pipe will be interconnected with the necessary valving to the recirculation piping, to increase operational flexibility in mixing the tank contents.

#### **84.2.5 Emergency Overflow**

An unvalved vented overflow will be provided to prevent damage to the digestion tank and cover in case of accidental overfilling. This emergency overflow will be piped to an appropriate point and at an appropriate rate in the treatment process or sidestream treatment facilities to minimize the impact on process units.

### **84.3 TANK CAPACITY**

#### **84.3.1 Rational Design**

The total digestion tank capacity will be determined by rational calculations based upon such factors as: volume of biosolids added, percent solids, and character; the temperature to be maintained in the digesters; the degree or extent of mixing to be obtained; the degree of volatile solids reduction required; the solids retention time at peak loadings; method of biosolids disposal and the size of the installation with appropriate allowances for gas, scum, supernatant, and digested biosolids storage. Secondary digesters of two-stage series digestion systems, which are utilized for, digested biosolids storage and concentration will not be credited in the calculations for volumes required for biosolids digestion. Calculations will be submitted to justify the basis of design.

#### **84.3.2 Standard Design**

When such calculations are not submitted to justify the design based on the above factors, the minimum digestion tank capacity outlined below will be required. Such requirements assume that the raw biosolids is derived from ordinary domestic wastewater, a digestion temperature is to be maintained in the



range of 85° to 95° F (29° to 35° C), 40 to 50 percent volatile matter in the digested biosolids, and that the digested biosolids will be removed frequently from the process. (See also paragraphs 84.1.1 and 89.1.1.)

Table 84.3\*

Effect of biosolids concentration and hydraulic detention time on volatile solids loading factor<sup>a</sup>

Biosolids Concentration, %	Volatile solids loading factor							
	lb/ft <sup>3</sup> -d				kg/m <sup>3</sup> -d			
	10db	12d	15d	20d	10d	12d	15d	20d
2	0.09	0.16	0.06	0.04	1.4	1.2	0.95	0.70
3	0.13	0.11	0.09	0.07	2.1	1.8	1.4	1.1
4	0.18	0.15	0.12	0.09	2.9	2.4	1.9	1.4
5	0.22	0.19	0.22	0.17	3.6	3.0	2.4	1.8
6	0.27	0.22	0.18	0.13	4.3	3.6	2.9	2.1
7	0.31	0.26	0.21	0.16	5.0	4.2	3.3	2.5
8	0.36	0.30	0.24	0.18	5.7	4.8	3.8	2.9

<sup>a</sup> Based on 70% volatile content of biosolids and a biosolids specific gravity of 1.02 (concentration effects neglected).

<sup>b</sup> Hydraulic detention time, ' d.

\* Table taken from Wastewater Engineering Treatment, Disposal, and Reuse, Metcalf & Eddy, Inc., Fourth Edition pg. 1514.

### 84.3.2.1 Multistage Systems

For digestion systems utilizing two stages (primary and secondary units), the first stage (primary) may be either completely mixed or moderately mixed and loaded in accordance with paragraphs 84.3.2.1 or 84.3.2.2. The second stage (secondary) is to be designed for biosolids storage, concentration, and gas collection and will not be credited in the calculations for volumes required for biosolids digestion.

### 84.3.2.2 Digester Mixing

Facilities for mixing the digester contents will be provided where required for proper digestion by reason of loading rates or other features of the system. Where biosolids recirculation pumps are used for mixing they will be provided in accordance with appropriate requirements of paragraph 87.1.



## **84.4 GAS COLLECTION, PIPING, AND APPURTENANCES**

### **84.4.1 General**

All portions of the gas system including the space above the tank liquor, storage facilities, and piping will be so designed that under all normal operating conditions, including biosolids withdrawal, the gas will be maintained under pressure. All enclosed areas where any gas leakage may occur will be adequately ventilated.

### **84.4.2 Safety Equipment**

All necessary safety facilities will be included where gas is produced. Pressure and vacuum relief valves and flame traps together with automatic safety shut off valves will be provided and protected from freezing. Water seal equipment will not be installed. Safety equipment and gas compressors will be housed in a separate room with an exterior door.

### **84.4.3 Gas Piping and Condensate**

Gas piping will have a minimum diameter of 4 inches (100 mm). A smaller diameter pipe at the gas production meter is acceptable. Gas piping will slope to condensation traps at low points. The use of float-controlled condensate traps is not permitted. Condensation traps will be protected from freezing.

Tightly fitted self-closing doors will be provided at connecting passageways and tunnels which connect digestion facilities to other facilities to minimize the spread of gas. Piping galleries will be ventilated in accordance with paragraph 84.4.7.

### **84.4.4 Gas Utilization Equipment**

Gas burning boilers, engines, etc., will be located in well-ventilated rooms. Such rooms will not ordinarily be classified as a hazardous location if isolated from the digestion gallery. Gas lines to these units will be provided with suitable flame traps.

### **84.4.5 Electrical Equipment, Fixtures, and Controls**

Electrical equipment, fixtures and controls, in places enclosing and adjacent to anaerobic digestion appurtenances, where hazardous gases may accumulate will comply with the National Electric Code for Class 1, Group D, Division 1 locations.



## **84.4.6 Waste Gas**

### **84.4.6.1 Location**

Waste gas burners will be readily accessible and will be located at least 50 feet (15.2 m) away from any plant structure. Waste gas burners will be of sufficient height and so located to prevent injury to personnel due to wind or downdraft conditions.

### **84.4.6.2 Pilot Light**

All waste gas burners will be equipped with automatic ignition such as a pilot light or a device using a photoelectric cell sensor. Consideration will be given to the use of natural or propane gas to insure reliability of the pilot.

## **84.4.7 Gas Piping Slope**

Gas piping will be sloped at a minimum of 2 percent up to the waste gas burner with a condensate trap provided in a location not subject to freezing.

## **84.4.8 Ventilation**

Any underground enclosures connecting with digestion tanks or containing biosolids or gas piping or equipment will be provided with forced ventilation for dry wells in accordance with Chapter 40, paragraphs 42.7.1 through 42.7.4 and 42.7.6. The ventilation rate for Class 1, Group D, Division 2 locations including enclosed areas without a gas tight partition from the digestion tank or areas containing gas compressors, sediments traps, drip traps, gas scrubbers, or pressure regulating and control valves, if continuous, will be at least 12 complete air changes per hour.

## **84.4.9 Meter**

A gas meter with bypass will be provided to meter total gas production for each active digestion unit. Total gas production for two-stage digestion systems operated in series may be measured by a single gas meter with proper interconnected gas piping.

Where multiple primary digestion units are utilized with a single secondary digestion unit, a gas meter will be provided for each primary digestion unit. The



secondary digestion unit may be interconnected with the gas measurement unit of one of the primary units. Interconnected gas piping will be properly valved with gas tight gate valves to allow measurement of gas production from either digestion unit or maintenance of either digestion unit.

Gas meters may be of the orifice plate, turbine or vortex type. Positive displacement meters will not be utilized. The meter will be specifically designed for contact with corrosive and dirty gases.

## **84.5 DIGESTION TANK HEATING**

### **84.5.1 Insulation**

Wherever possible digestion tanks will be constructed above ground-water level and will be suitably insulated to minimize heat loss. Maximum utilization of earthen bank insulation will be used.

### **84.5.2 Heating Facilities**

Biosolids may be heated by circulating the biosolids through external heaters or by units located inside the digestion tank. Refer to paragraph 84.5.2.2.

#### **84.5.2.1 External Heating**

Piping will be designed to provide for the preheating of feed biosolids before introduction into the digesters. Provisions will be made in the layout of the piping and valving to facilitate heat exchanger tube removal and cleaning of the lines. Heat exchanger biosolids piping will be sized for peak heat transfer requirements. Heat exchangers will have a heating capacity of 130 percent of the calculated peak heating requirement to account for the occurrence of biosolids tube fouling.

#### **84.5.2.2 Other Heating Methods**

- a. The use of hot water heating coils affixed to the walls of the digester, or other types of internal heating equipment that require emptying the digester contents for repair, are not acceptable.
- b. Other systems and devices have been developed recently to provide both mixing and heating of anaerobic digester contents. These systems will be reviewed on their own



merits. Operating data detailing their reliability, operation, and maintenance characteristics will be required. Refer to Chapter 50, paragraph 53.2.

### **84.5.3 Heating Capacity**

#### **84.5.3.1 Capacity**

Sufficient heating capacity will be provided to consistently maintain the design biosolids temperature considering insulation provisions and ambient cold weather conditions. Where digestion tank gas is used for other purposes, an auxiliary fuel may be required. The design operating temperature will be in the range of 85° to 100° F (29° to 38°C) where optimum mesophilic digestion is required.

#### **84.5.3.2 Standby Requirements**

The provision of standby heating capacity or the use of multiple units sized to provide the heating requirements will be considered unless acceptable alternative means of handling raw biosolids are provided for the extended period that digestion process outage is experienced due to heat loss.

### **84.5.4 Hot Water Internal Heating Controls**

#### **84.5.4.1 Mixing Valves**

A suitable automatic mixing valve will be provided to temper the boiler water with return water so that the inlet water to the removable heat jacket or coil in the digester can be held below a temperature at which caking will be accentuated. Manual control will also be provided by suitable bypass valves.

#### **84.5.4.2 Boiler Controls**

The boiler will be provided with suitable automatic controls to maintain the boiler temperature at approximately 180° F (82°C) to minimize corrosion and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level, low gas pressure, or excessive boiler water temperature or pressure.



#### **84.5.4.3     *Boiler Water Pumps***

Boiler water pumps will be sealed and sized to meet the operating conditions of temperature, operating head, and flow rate. Duplicate units will be provided.

#### **84.5.4.4     *Thermometers***

Thermometers will be provided to show inlet and outlet temperatures of the biosolids, hot water feed, hot water return, and boiler water.

#### **84.5.4.5     *Water Supply***

The chemical quality will be checked for suitability for this use. Refer to paragraph 56.2.3 for required break tank for indirect water supply connections.

### **84.5.5     *External Heater Operating Controls***

All controls necessary to insure effective and safe operation are required. Provision for duplicate units in critical elements will be considered.

## **84.6     *SUPERNATANT WITHDRAWAL***

Where supernatant separation is to be used to concentrate biosolids in the digester units and increase digester solids retention time, the design will provide for ease of operation and positive control of supernatant quality.

### **84.6.1     *Piping Size***

Supernatant piping will not be less than 6 inches (150 mm) in diameter.

### **84.6.2     *Withdrawal Arrangements***

#### **84.6.2.1     *Withdrawal Levels***

Piping will be arranged so that withdrawal can be made from 3 or more levels in the tank. An unvalved vented overflow will be provided. The emergency overflow will be piped to an appropriate point and at an appropriate rate in the treatment process or side stream treatment units to minimize the impact on process units.



#### **84.6.2.2      *Withdrawal Selection***

On fixed cover tanks, the supernatant withdrawal level will preferably be selected by means of interchangeable extensions at the discharge end of the piping.

#### **84.6.2.3      *Supernatant Selector***

A fixed screen supernatant selector or similar type device will be limited for use in an unmixed secondary digestion unit. If such supernatant selector is provided, provisions will be made for at least one other draw-off level located in the supernatant zone of the tank, in addition to the unvalved emergency supernatant draw-off pipe. High-pressure backwash facilities will be provided.

#### **84.6.3      *Sampling***

Provisions will be made for sampling at each supernatant draw-off level. Sampling pipes will be at least 1½ inches (40 mm) in diameter and will terminate at a suitably sized sampling sink or basin.

#### **84.6.4      *Supernatant Disposal***

Supernatant return and disposal facilities will be designed to alleviate adverse hydraulic and organic effects on plant operations. If nutrient removal (e.g., phosphorus, ammonia nitrogen) will be accomplished at a plant, then a separate supernatant side stream treatment system will be provided.

#### **84.6.5      *Mixed Biosolids***

Anaerobic digester supernatant of good quality is typically impossible to achieve when co-digesting waste activated biosolids with primary biosolids.

### **84.7      ANAEROBIC DIGESTION BIOSOLIDS PRODUCTION**

For calculating design biosolids handling and disposal needs, biosolids production values from a two-stage anaerobic digestion process will be based on a maximum solids concentration of 5 percent without additional thickening. The solids production values on a dry weight basis will be based on the following for the listed processes:





Primary plus waste activated biosolids at least 0.12 lbs./P.E.(Population Equivalent)/day (0.05 kg/P.E./day). Primary plus fixed film biosolids at least 0.09 lbs./P.E/day (0.04 kg/P.E./day).

## **85. AEROBIC BIOSOLIDS DIGESTION**

### **85.1 GENERAL**

The aerobic biosolids digestion system will include provisions for digestion, supernatant separation, biosolids concentration, and any necessary biosolids storage. These provisions may be accomplished by separate tanks or processes, or in the digestion tanks.

### **85.2 MULTIPLE UNITS**

Multiple digestion units capable of independent operation are desirable and will be provided in all plants where the design average flow exceeds 100,000 gallons per day (379 m<sup>3</sup>/d). All plants not having multiple units will provide alternate biosolids handling and disposal methods.

### **85.3 TANK CAPACITY**

#### **85.3.1 Volume Required**

The following digestion tank capacities are based on a solids concentration of 2 percent with supernatant separation performed in a separate tank. If supernatant separation is performed in the digestion tank, a minimum of 25 percent additional volume is required. These capacities will be provided unless biosolids thickening facilities (refer to Section 83) are utilized to thicken the feed solids concentration to greater than 2 percent. If such thickening is provided, the digestion volumes may be decreased proportionally.



<u>Biosolids Source</u>	<u>Volume/Pop. ft<sup>3</sup>/P.E.</u>	<u>Equiv. (P.E.) (m<sup>3</sup>/P.E.)</u>
Waste activated biosolids -- no primary Settling	4.5*	(0.13)
Primary plus waste activated biosolids	4.0*	(0.11)
Waste activated biosolids exclusive of primary biosolids	2.0*	(0.06)
Extended aeration activated biosolids	3.0	(0.09)
Primary plus fixed film reactor biosolids	3.0	(0.09)

\*These volumes also apply to waste activated biosolids from single stage nitrification facilities with less than 24 hours detention time based on design average flow.

### **85.3.2 Effect of Temperature on Volume**

The volumes in paragraph 85.3.1 are based on digester temperatures of 59°F (15°C) and a solids retention time of 27 days. Aerobic digesters will be covered to minimize heat loss for colder temperature applications. Additional volume or supplemental heat may be required if the land application disposal method is used in order to meet applicable U.S. EPA requirements (40 CFR 503). Refer to paragraph 85.9 for necessary biosolids storage.

## **85.4 MIXING**

Aerobic digesters will be provided with mixing equipment, which can maintain solids in suspension and insure complete mixing of the digester contents. Refer to paragraph 85.5.

## **85.5 AIR REQUIREMENTS**

Sufficient air will be provided to keep the solids in suspension and maintain dissolved oxygen between 1 and 2 milligrams per liter (mg/l). For minimum mixing and oxygen requirements, an air supply of 30 cf per 1000 cubic feet (0.5 L/s/m<sup>3</sup>) of tank volume will be provided with the largest blower out of service. If diffusers are used, the nonclog type is recommended, and they will be designed



to permit continuity of service. If mechanical turbine aerators are utilized, at least two turbine aerators per tank will be provided to permit continuity of service. Mechanical aerators are not recommended for use in aerobic digesters where freezing conditions will cause ice build-up on the aerator and support structures.

## **85.6 NITRIFICATION AND DENITRIFICATION**

Low pH can occur in aerobic digesters due to nitrification in the presence of lightly buffered waters and provisions will be made for pH adjustment in these cases. This can be accomplished by incorporated cyclic aeration to achieve denitrification, and adding this feature for denitrification will be considered for all aerobic digesters.

## **85.7 SUPERNATANT SEPARATION AND SCUM AND GREASE REMOVAL**

### **85.7.1 Supernatant Separation**

Facilities will be provided for effective separation or decanting of supernatant. Separate facilities are recommended; however, supernatant separation may be accomplished in the digestion tank provided additional volume is provided per paragraph 85.3.1. The supernatant draw-off unit will be designed to prevent recycle of scum and grease back to plant process units. Provision will be made to withdraw supernatant from multiple levels of the supernatant withdrawal zone.

### **85.7.2 Scum and Grease Removal**

Facilities will be provided for the effective collection of scum and grease from the aerobic digester for final disposal and to prevent its recycle back to the plant process and to prevent long term accumulation and potential discharge in the effluent.

## **85.8 HIGH LEVEL EMERGENCY OVERFLOW**

An unvalved high level overflow and any necessary piping will be provided to return digester overflow back to the head of the plant or to the aeration process in case of accidental overfilling. Design considerations related to the digester overflow will include waste biosolids rate and duration during the period the plant is unattended, potential effect on plant process units, discharge location of the emergency overflow, and potential discharge of suspended solids in the plant effluent.



## 85.9 AEROBIC DIGESTION BIOSOLIDS PRODUCTION

For calculating design biosolids handling and disposal needs, biosolids production values from aerobic digesters will be based on a maximum solids concentration of 2 percent without additional thickening. The solids production values on a dry weight basis will be based on the following for the listed processes:

- a. Primary plus waste activated biosolids - at least 0.16 lbs./P.E./day (0.07 kg/P.E./day).
- b. Primary plus fixed film biosolids - at least 0.12 lbs./P.E./day (0.05 kg/P.E./day).
- c. No primary plus waste activated biosolids – at least 0.13 lbs/P.E. d (0.17 lbs influent BOD/P.E./ d x 1.1 yield x 70% assuming 30% solids destruction in digester)

## 85.10 DIGESTION BIOSOLIDS STORAGE VOLUME

### 85.10.1 Biosolids Storage Volume

Biosolids storage will be provided in accordance with Section 89 to accommodate daily biosolids production volumes and as an operational buffer for unit outage and adverse weather conditions. Designs utilizing increased biosolids age in the activated biosolids system as a means of storage are not acceptable.

### 85.10.2 Liquid Biosolids Storage

Liquid biosolids storage facilities will be based on the following values unless digested biosolids thickening facilities are utilized (refer to Section 83) to provide solids concentrations of greater than 2 percent.

<u>Biosolids Source</u>	<u>ft<sup>3</sup>/P.E./day</u>	<u>Volume (m<sup>3</sup>/P.E./day)</u>
Waste activated biosolids -- no primary settling, primary plus waste activated biosolids, and extended aeration activated biosolids	0.13	(0.004)
Waste activated biosolids exclusive of primary biosolids	0.06	(0.002)
Primary plus fixed film reactor biosolids	0.10	(0.003)



## **86. HIGH pH STABILIZATION**

### **86.1 GENERAL**

Alkaline material may be added to liquid primary or secondary biosolids for biosolids stabilization in lieu of digestion facilities; to supplement existing digestion facilities; or for interim biosolids handling. There is no direct reduction of organic matter or biosolids solids with the high pH stabilization process. There is an increase in the mass of dry biosolids solids. Without supplemental dewatering, additional volumes of biosolids will be generated. The design will account for the increased biosolids quantities for storage, handling, transportation, and disposal methods and associated costs.

### **86.2 OPERATIONAL CRITERIA**

Sufficient alkaline material will be added to liquid biosolids in order to produce a homogeneous mixture with a minimum pH of 12 after 2 hours of vigorous mixing. Facilities for adding supplemental alkaline material will be provided to maintain the pH of the biosolids during interim biosolids storage periods.

### **86.3 ODOR CONTROL AND VENTILATION**

Odor control facilities will be provided for biosolids mixing and treated biosolids storage tanks when located within 1/2 mile (0.8 km) of residential or commercial areas. The reviewing authority will be contacted for design and air pollution control objectives to be met for various types of air scrubber units. Ventilation is required for indoor biosolids mixing, storage or processing facilities in accordance with Chapter 40, paragraph 42.7.

### **86.4 MIXING TANKS AND EQUIPMENT**

#### **86.4.1 Tanks**

Mixing tanks may be designed to operate as either a batch or continuous flow process. A minimum of two tanks will be provided of adequate size to provide a minimum 2 hours contact time in each tank. The following items will also be considered in determining the number and size of tanks:

- a. peak biosolids flow rates;
- b. storage between batches;
- c. dewatering or thickening performed in tanks;



- d. repeating biosolids treatment due to pH decay of stored biosolids;
- e. biosolids thickening prior to biosolids treatment; and
- f. type of mixing device used and associated maintenance or repair requirements.

#### **86.4.2 Equipment**

Mixing equipment will be designed to provide vigorous agitation within the mixing tank, maintain solids in suspension and provide for a homogeneous mixture of the biosolid solids and alkaline material. Mixing may be accomplished either by diffused air or mechanical mixers. If diffused aeration is used, an air supply of 30 cfm per 1000 cubic feet ( $0.5 \text{ L/s/m}^3$ ) of mixing tank volume will be provided with the largest blower out of service.

When diffusers are used, the nonclog type is recommended, and they will be designed to permit continuity of service. If mechanical mixers are used, the impellers will be designed to minimize fouling with debris in the biosolids and consideration will be made to provide continuity of service during freezing weather conditions.

### **86.5 CHEMICAL FEED AND STORAGE EQUIPMENT**

#### **86.5.1 General**

Alkaline material is caustic in nature and can cause eye and tissue injury. Equipment for handling or storing alkaline material will be designed for adequate operator safety. Refer to Chapter 50, Section 57 for proper safety precautions. Storage, slaking, and feed equipment will be sealed as airtight as practical to prevent contact of alkaline material with atmospheric carbon dioxide and water vapor and to prevent the escape of dust material. All equipment and associated transfer lines or piping will be accessible for cleaning.

#### **86.5.2 Feed and Slaking Equipment**

The design of the feeding equipment will be determined by the treatment plant size, type of alkaline material used, slaking required, and operator requirements. Equipment may be either of batch or automated type. Automated feeders may be of the volumetric or gravimetric type depending on accuracy, reliability, and maintenance requirements. Manually operated batch slaking of quicklime ( $\text{CaO}$ ) will be avoided unless adequate protective clothing and equipment are provided. At small plants, use of hydrated lime [ $\text{Ca}(\text{OH})_2$ ] is recommended over quicklime



due to safety and laborsaving reasons. Feed and slaking equipment will be sized to handle a minimum of 150% of the peak biosolids flow rate including biosolids that may need to be retreated due to pH decay. Duplicate units will be provided.

### **86.5.3 Chemical Storage Facilities**

Alkaline materials may be delivered either in bag or bulk form depending upon the amount of material used. Material delivered in bags will be stored indoors and elevated above floor level. Bags will be of the multi-wall moisture-proof type. Dry bulk storage containers will be as airtight as practical and will contain a mechanical agitation mechanism. Storage facilities will be sized to provide a minimum of a 30-day supply.

## **86.6 BIOSOLIDS STORAGE**

Refer to Section 89 for general design considerations for biosolids storage facilities. The design will incorporate the following considerations for the storage of high pH stabilized biosolids:

### **86.6.1 Liquid Biosolids**

Liquid high pH stabilized biosolids will not be stored in a lagoon. Said biosolids will be stored in a tank or vessel equipped with rapid biosolids withdrawal mechanisms for biosolids disposal or retreatment. Provisions will be made for adding alkaline material in the storage tank. Mixing equipment in accordance with paragraph 86.4.2 above will also be provided in all storage tanks.

### **86.6.2 Dewatered Biosolids**

On-site storage of dewatered high pH stabilized biosolids will be limited to 30 days. Provisions for rapid retreatment or disposal of dewatered biosolids stored on-site will also be made in case of biosolids pH decay.

### **86.6.3 Off-Site Storage**

There will be no off-site storage of high pH stabilized biosolids unless specifically permitted by the regulatory agency.

## **86.7 DISPOSAL**

Immediate biosolids disposal methods and options are recommended to be utilized in order to reduce the biosolids inventory on the treatment plant site and



amount of biosolids that may need to be retreated to prevent odors if biosolids pH decay occurs. If the land application disposal option is utilized for high pH stabilized biosolids, said biosolids will be incorporated into the soil during the same day of delivery to the site.

## **87. BIOSOLIDS PUMPS AND PIPING**

### **87.1 BIOSOLIDS PUMPS**

#### **87.1.1 Capacity**

Pump capacities will be adequate but not excessive. Provision for varying pump capacity is desirable. A rational basis of design will be provided with the plan documents.

#### **87.1.2 Duplicate Units**

Duplicate units will be provided at all installations.

#### **87.1.3 Type**

Plunger pumps, progressing cavity, diaphragm pumps or other types of pumps with demonstrated solids handling capability will be provided for handling raw biosolids. Where centrifugal pumps are used, a parallel positive displacement pump will be provided as an alternate to pump heavy biosolids concentrations, such as primary or thickened biosolids, that may exceed the pumping head of the centrifugal pump.

#### **87.1.4 Minimum Head**

A minimum positive head of 24 inches (610 mm) will be provided at the suction side of centrifugal type pumps and is desirable for all types of biosolids pumps. Maximum suction lifts will not exceed 10 feet (3 m) for plunger pumps. Biosolids friction loss calculations will account for acceleration loss when using plunger pumps.

#### **87.1.5 Sampling Facilities**

Unless biosolids-sampling facilities are otherwise provided, quick-closing sampling valves will be installed at the biosolids pumps. The size of valve and piping will be at least 1½ inches (40 mm) and terminate at a suitably sized sampling sink or floor drain.





## **87.2 BIOSOLIDS PIPING**

### **87.2.1 Size and Head**

Digested biosolids withdrawal piping will have a minimum diameter of 8 inches (200mm) for gravity withdrawal and 6 inches (150 mm) for pump suction and discharge lines. Where withdrawal is by gravity, the available head on the discharge pipe will be at least 4 feet (1.2 m) and preferably more. Undigested biosolids withdrawal piping will be sized in accordance with Chapter 70, paragraph 73.2.3.

### **87.2.2 Slope and Flushing Requirements**

Gravity piping will be laid on uniform grade and alignment. Slope on gravity discharge piping will not be less than 3 percent for primary biosolids and all biosolids thickened to greater than 2 percent solids. Slope on gravity discharge piping will not be less than 2 percent for aerobically digested biosolids or waste activated biosolids with less than 2 percent solids. Cleanouts will be provided for all gravity biosolids piping. Provisions will be made for draining and flushing discharge lines. All biosolids piping will be suitably located or otherwise adequately protected to prevent freezing.

### **87.2.3 Supports**

Special consideration will be given to the corrosion resistance and permanence of supporting systems for piping located inside the digestion tank.

## **88. BIOSOLIDS DEWATERING**

### **88.1 GENERAL**

On-site biosolids dewatering facilities will be provided for all plants, although the following requirements may be reduced with on-site liquid biosolids storage facilities or approved off-site biosolids disposal.

For calculating design biosolids handling and disposal needs for biosolids stabilization processes other than described in paragraphs 84.7 for anaerobic digestion and 85.8 for aerobic digestion, a rational basis of design for biosolids production values will be developed and provided to the reviewing authority for approval on a case-by-case basis.



## **88.2 BIOSOLIDS DRYING BEDS**

### **88.2.1 Applicability**

Biosolids drying beds may be used for dewatering well-digested biosolids from either the anaerobic or aerobic process. Due to the large volume of biosolids produced by the aerobic digestion process, consideration will be given to using a combination of dewatering systems or other means of ultimate biosolids disposal.

### **88.2.2 Unit Sizing**

Biosolids drying bed area will be calculated on a rational basis with the following items considered:

- a. The volume of wet biosolids produced by existing and proposed processes.
- b. Depth of wet biosolids drawn to the drying beds. For design calculation purposes a maximum depth of 8 inches (200 mm) will be utilized. For operational purposes, the depth of biosolids placed on the drying bed may increase or decrease from the design depth based on the percent solids content and type of digestion utilized.
- c. Total digester volume and other wet biosolids storage facilities.
- d. Degree of biosolids thickening provided after digestion.
- e. The maximum drawing depth of biosolids, which can be, removed from the digester or other biosolids storage facilities without causing process or structural problems.
- f. The time required on the bed to produce a removable cake. Adequate provision will be made for biosolids dewatering and/or biosolids disposal facilities for those periods of time during which outside drying of biosolids on beds is hindered by weather.
- g. Capacities of auxiliary dewatering facilities.



### **88.2.3 Percolation Type Bed Components**

#### **88.2.3.1 Gravel**

The lower course of gravel around the underdrains will be properly graded and will be at least 12 inches (300 mm) in depth, extending at least 6 inches (150 mm) above the top of the underdrains. It is desirable to place this in two or more layers. The top layer of at least 3 inches (80 mm) will consist of gravel 1/8 inch to 1/4 inch (3 to 6 mm) in size.

#### **88.2.3.2 Sand**

The top course will consist of at least 9 to 12 inches (230 to 300 mm) of clean, hard, and washed coarse sand. The effective size of the sand will be in the range of 0.8 to 1.5 millimeter (mm). The finished sand surface will be level.

#### **88.2.3.3 Underdrains**

Underdrains will be at least 4 inches (100 mm) in diameter laid with open joints. Perforated pipe may also be used. Underdrains will be spaced not more than 20 feet (6.1m) apart and sloped at a minimum of 1 percent. Lateral tiles will be spaced at 8 to 10 feet (2.4 to 3.0m). Various pipe materials may be selected provided the pipe is corrosion resistant and appropriately bedded to insure that the underdrains are not damaged by biosolids removal equipment.

#### **88.2.3.4 Additional Dewatering Provisions**

Consideration will be given for providing a means of decanting the supernatant of biosolids placed on the biosolids drying beds. More effective decanting of supernatant may be accomplished with chemical treatment of biosolids.

#### **88.2.3.5 Bed Liners**

Bed liners must meet manufacturer specifications and installation in accordance with State regulatory requirements.



#### **88.2.4 Walls**

Walls will extend 18 inches (460 mm) above and at least 9 inches (230 mm) below the surface of the bed. Outer walls will be water tight down to the bottom of the bed and extend at least 4 inches (100 mm) above the outside grade elevation to prevent soil from washing into the beds.

#### **88.2.5 Biosolids Removal**

Each bed will be constructed so as to be readily and completely accessible to mechanical equipment for cleaning and sand replacement. Concrete runways spaced to accommodate mechanical equipment will be provided. Special attention will be given to assure adequate access to the areas adjacent to the sidewalls. Entrance ramps down to the level of the sand bed will be provided. These ramps will be high enough to eliminate the need for an entrance end wall for the biosolids beds.

### **88.3 MECHANICAL DEWATERING FACILITIES**

#### **88.3.1 General**

Provisions will be made to maintain sufficient continuity of service so that biosolids may be dewatered without accumulation beyond storage capacity. The number of vacuum filters, centrifuges, filter presses, belt filters, other mechanical dewatering facilities, or combinations thereof will be sufficient to dewater the biosolids produced with the largest unit out of service. Unless other standby wet biosolids facilities are available, adequate storage facilities of at least 4 days production volume in addition to any other biosolids storage needs will be provided. Documentation will be submitted justifying the basis of design of mechanical dewatering facilities.

#### **88.3.2 Water Supply Protection**

Provisions for water supply to mechanical dewatering facilities will be in accordance with Chapter 50, paragraph 56.2.3.

#### **88.3.3 Ventilation**

Adequate facilities will be provided for ventilation of the dewatering area in accordance with Chapter 40, paragraph 42.7. The exhaust air will be properly conditioned to avoid odor nuisance.



#### **88.3.4 Chemical Handling Enclosures**

Chemical feed facilities will be completely enclosed to protect equipment and prevent escape of fugitive chemicals. Chemical handling equipment will be automated to eliminate manual lifting. Refer to Chapter 50, Section 57.

### **88.4 DRAINAGE AND FILTRATE DISPOSAL**

Drainage from biosolids drying beds or filtrate from other dewatering units will be returned to the wastewater treatment process at appropriate points and rates. (See also Chapter 50, paragraph 56.7, Chapter 90, paragraph 92.3.3.1.2, and paragraph 84.6.4.)

### **88.5 OTHER DEWATERING FACILITIES**

If it is proposed to dewater biosolids by other methods, a detailed description of the process and design data will accompany the plans. Refer to Chapter 50, paragraph 53.2 for any new process determinations.

## **89. BIOSOLIDS STORAGE AND DISPOSAL**

### **89.1 STORAGE**

#### **89.1.1 General**

Biosolids storage facilities will be provided at all mechanical treatment plants. Appropriate storage facilities may consist of any combination of drying beds, lagoons, separate tanks, additional volume in biosolids stabilization units, storage capability within the wastewater treatment process, pad areas or other means to store either liquid or dried biosolids. Refer to paragraphs 88.2 and 89.2 for drying bed and lagoon design criteria, respectively.

The design will provide for odor control in biosolids storage tanks and biosolids lagoons including aeration, covering, or other appropriate means.

#### **89.1.2 Volume**

Rational calculations justifying the number of days of storage to be provided will be submitted and will be based on the total biosolids handling and disposal system. Refer to paragraphs 84.7 and 85.9 for anaerobically and aerobically



digested biosolids production values. Biosolids production values for other stabilization processes will be justified in the basis of design. If the land application method of biosolids disposal is the only means of disposal utilized at a treatment plant, storage will be provided based on considerations including at least the following items:

- a. Inclement weather effects on access to the application land.
- b. Temperatures including frozen ground and stored biosolids cake conditions.
- c. Haul road restrictions including spring thawing conditions.
- d. Area seasonal rainfall patterns.
- e. Cropping practices on available land.
- f. Potential for increased biosolids volumes from industrial sources during the design life of the plant.
- g. Available area for expanding biosolids storage.
- h. Appropriate pathogen reduction and vector attraction reduction requirements.

A storage capacity of up to 180 days storage will be considered for the design life of the plant. Refer to paragraph 89.3.3 for other biosolids land application considerations.

## **89.2 BIOSOLIDS STORAGE LAGOONS**

### **89.2.1 General**

Biosolids storage lagoons will be permitted only upon proof that the character of the digested biosolids and the design mode of operation are such that offensive odors will not result. Where biosolids lagoons are permitted, adequate provisions will be made for other acceptable biosolids handling methods in the event of upset or failure of the biosolids digestion process.

### **89.2.2 Location**

Biosolids lagoons will be located as far as practicable from inhabited areas or areas likely to be inhabited during the lifetime of the structures. Siting of biosolids lagoons will comply with the requirements of the reviewing authority.

### **89.2.3 Seal**

Adequate provisions will be made to seal the biosolids lagoon bottoms and embankments to prevent leaching into adjacent soils or ground water. The seal



will be protected to prevent damage from biosolids removal activities. Groundwater monitoring may be required by the reviewing authority.

#### **89.2.4 Access**

Provisions will be made for pumping or heavy equipment access for biosolids removal from the biosolids lagoon on a routine basis.

#### **89.2.5 Supernatant Disposal**

Lagoon supernatant will be returned to the wastewater treatment process at appropriate points and rates. (See also Chapter 50, paragraph 56.7 and paragraph 84.6.4.)

### **89.3 DISPOSAL**

#### **89.3.1 General**

Drainage facilities for biosolids vehicle transfer stations will be provided to allow any spillage or washdown material to be collected and returned to the wastewater treatment plant or biosolids storage facility.

#### **89.3.2 Sanitary Landfilling**

Biosolids and biosolids residues may be disposed of in approved sanitary landfills under the terms and conditions of the regulatory agency.

#### **89.3.3 Land Application**

The reviewing authority will be contacted for specific design and approval requirements governing land application of municipal biosolids. Additional operating criteria may be obtained from applicable federal regulations and the New Mexico Water Quality Control Commission Regulations (groundwater discharge permits). Biosolids may be utilized as a soil conditioner for agricultural, horticultural, or reclamation purposes. Important design considerations include but are not necessarily limited to: biosolids stabilization process, appropriate pathogen and vector attraction reduction, biosolids characteristics including the presence of inorganic and organic chemicals, application site characteristics (soils, groundwater elevations, setback distance requirements, etc.), local topography and hydrology, cropping practices, spreading and incorporation techniques, population density and odor control, local groundwater quality and usage.



Biosolids mixing equipment or other provisions to assist in the monitoring of land-applied biosolids will be considered in the design of biosolids handling and storage facilities.

Due to inclement weather and cropping practices, alternative biosolids disposal options are recommended to ensure the biosolids are properly managed. Biosolids will not be applied to land which is used for growing food crops to be eaten raw, such as leafed vegetables and root crops.

#### **89.3.4 Biosolids Lagoons for Disposal**

The utilization of lagoons for ultimate disposal of biosolids is not recommended due to odor potential, area and volume required, and possible long term problems from groundwater contamination. The regulatory agency will be contacted for the acceptability of lagoons for final disposal.

#### **89.3.5 Other Disposal Methods**

If it is proposed to dispose of biosolids by other methods, a detailed description of the technique and design data will accompany the plans. Refer to Chapter 50, paragraph 53.2 for any new process determinations.





## CHAPTER 90

### BIOLOGICAL TREATMENT

#### 91. TRICKLING FILTERS

##### 91.1 GENERAL

Trickling filters may be used for treatment of wastewater amenable to treatment by aerobic biological processes. Trickling filters will be preceded by effective settling tanks equipped with scum and grease collecting devices, or other suitable pretreatment facilities. Filters will be designed to provide for reduction in carbonaceous and/or nitrogenous oxygen demand in accordance with water quality standards and objectives for the receiving waters as established by the appropriate reviewing authority, or to properly condition the wastewater for subsequent treatment processes. Multi-stage filters will be considered if needed to meet more stringent effluent standards, including nitrification.

##### 91.2 HYDRAULICS

###### 91.2.1 Distribution

###### 91.2.1.1 *Uniformity*

The wastewater may be distributed over the filter by rotary distributors or other suitable devices, which will ensure uniform distribution to the surface area. At design average flow, the deviation from a calculated uniformly distributed volume per square foot ( $\text{m}^2$ ) of the filter surface will not exceed plus or minus 10% at any point. All hydraulic factors involving proper distribution of wastewater on the filters will be carefully calculated. Such calculations will be submitted to the appropriate reviewing authority.

Reverse reaction nozzles or hydraulic brakes will be provided to not exceed the maximum speed recommended by the distributor manufacturer and to attain the desired media flushing rate.



### **91.2.1.2 Head Requirements**

For reaction type distributors, a minimum head of 24 inches (610mm) between low water level in the siphon chamber and center of the arms is required. Similar allowance in design will be provided for added pumping head requirements where pumping to the reaction type distributor is used.

### **91.2.1.3 Clearance**

A minimum clearance of 12 inches (300 mm) between media and distribution arms will be provided.

## **91.2.2 Dosing**

Wastewater may be applied to the filters by siphons, pumps or by gravity discharge from preceding treatment units when suitable flow characteristics have been developed. Application of the wastewater will be practically continuous. The piping system will be designed for recirculation.

## **91.2.3 Piping System**

The piping system, including dosing equipment and distributor, will be designed to provide capacity for the design peak hourly flow, including recirculation required under paragraph 91.5.5.

# **91.3 MEDIA**

## **91.3.1 Quality**

The media may be crushed rock, slag, or manufactured material. The media will be durable, resistant to spalling or flaking and relatively insoluble in wastewater. The top 18 inches (460 mm) will have a loss by the 20-cycle, sodium sulfate soundness test of not more than 10%, as prescribed by ASCE Manual of Engineering Practice, Number 13. The balance is to pass a 1 a-cycle test using the same criteria. Slag media will be free from iron or other leachable materials that will adversely affect the process or effluent quality. Manufactured media such as random pack media, will be resistant to ultraviolet degradation, disintegration, erosion, aging, all common acids and alkalis, organic compounds, and fungus and biological attack. Such media will be structurally capable of supporting a person's weight or a suitable access walkway will be provided to allow for distributor maintenance.



### 91.3.2 Depth

Trickling filter media will have a minimum depth of 6 feet (1.8 m) above the underdrains. Rock and/or slag filter media depths will not exceed 10 feet (3 m) and manufactured filter media depths will not exceed the recommendations of the manufacturer. Forced ventilation will be considered in accordance with paragraph 91.4.3.

### 91.3.3 Size, Grading, and Handling of Media

#### 91.3.3.1 *Rock, Slag, and Similar Media*

Rock, slag, and similar media will not contain more than 5% by weight of pieces whose longest dimension is three times the least dimension. They will be free from thin, elongated and flat pieces, dust, clay, sand or fine material and will conform to the following size and grading when mechanically graded:

- a) Passing 4½ inch (114 mm) screen - 100% by weight
- b) Retained on 3 inch (75 mm) screen - 95-100% by weight
- c) Passing 2 inch (50 mm) screen - 0-2% by weight
- d) Passing 1 inch (25 mm) screen - 0-1% by weight

#### 91.3.3.2 *Manufactured Media*

Suitability will be evaluated on the basis of experience with installations handling similar wastes and loadings. To insure sufficient void clearances, media with specific surface areas of no more than 30 square feet per cubic foot ( $100 \text{ m}^2/\text{m}^3$ ) are acceptable for filters employed for carbonaceous reduction, and 45 square feet per cubic foot ( $150 \text{ m}^2/\text{m}^3$ ) for second stage ammonia reduction.

#### 91.3.3.3 *Handling and Placing of Media*

Material delivered to the filter site will be stored on wood-planked or other approved clean, hard-surfaced areas. All material will be rehandled at the filter site and no material will be dumped directly into the filter. Crushed rock, slag, and similar media will be washed and rescreened or forked at the filter site to remove all fines. Such material will be placed by hand to a depth of 12 inches (300 mm) above the tile underdrains. The remainder of the material may be placed by means of belt conveyors or equally effective methods approved by the engineer. All material will be carefully



placed so as not to damage the underdrains. Manufactured media will be handled and placed as approved by the engineer. Trucks, tractors, and other heavy equipment will not be driven over the filter during or after construction.

## **91.4 UNDERDRAINAGE SYSTEM**

### **91.4.1 Arrangement**

Underdrains with semicircular inverts or equivalent will be provided and the underdrainage system will cover the entire floor of the filter. Inlet openings into the underdrains will have an unsubmerged gross combined area equal to at least 15% of the surface area of the filter.

### **91.4.2 Hydraulic Capacity**

The underdrains will have a minimum slope of 1%. Effluent channels will be designed to produce a minimum velocity of 2 feet per second (0.6 m/s) at design average flow rates of application to the filter including recirculated flows. Refer to paragraph 91.4.3.

### **91.4.3 Ventilation**

The underdrainage system, effluent channels, and effluent pipe will be designed to permit free passage of air. Design will provide a means for the operator to limit the flow of air through the filter in cold weather. The size of drains, channels, and pipe will be such that not more than 50% of their cross-sectional area will be submerged under the design peak instantaneous flow, including proposed or possible future recirculated flows.

Forced ventilation will be provided for covered trickling filters to insure adequate oxygen for process requirements. Windows or simple louvered mechanisms so arranged to ensure air distribution throughout the enclosure will be provided. The design of the ventilation facilities will provide for operator control of airflow in accordance with outside seasonal temperature. Design computations showing the adequacy of air flow to satisfy process oxygen requirements will be submitted.



#### **91.4.4 Flushing**

Provision will be made for flushing the underdrains unless high rate recirculation is utilized. In small rock and slag filters, use of a peripheral head channel with vertical vents is acceptable for flushing purposes. Inspection facilities will be provided.

### **91.5 SPECIAL FEATURES**

#### **91.5.1 Flooding**

Appropriate valves, sluice gates, or other structures will be provided to enable flooding of filters comprised of rock or slag media for filter fly control.

#### **91.5.2 Freeboard**

A freeboard of 4 feet (1.2 m) or more will be provided for tall, manufactured filters to contain windblown spray. Provide at least 6 feet (1.8 m) headroom for maintenance of the distributor on covered filters.

#### **91.5.3 Maintenance**

All distribution devices, underdrains, channels, and pipes will be installed so that they may be properly maintained, flushed or drained.

#### **91.5.4 Winter Protection**

Covers will be provided to maintain operation and treatment efficiencies when climatic conditions are expected to result in problems due to cold temperatures.

#### **91.5.5 Recirculation**

The piping system will be designed for recirculation as required to achieve the design efficiency. The recirculation rate will be variable and subject to plant operator control at the range of 0.5: 1 up to 3: 1 (ratio of recirculation rate versus design average flow). A minimum of two recirculation pumps will be provided.

#### **91.5.6 Recirculation Measurement**

Devices will be provided to permit measurement of the recirculation rate. Elapsed time meters and pump head recording devices are acceptable for facilities treating less than 1 MGD (3785 m<sup>3</sup>/d). The design of the recirculation



facilities will provide for both continuity of service and the range of recirculation ratios. Reduced recirculation rates for periods of brief pump outages may be acceptable depending on water quality requirements.

#### **91.5.7 Ventilation Ports**

The underdrainage ventilation ports will be designed to insure that the interior flow will be retained inside the trickling filter.

### **91.6 ROTARY DISTRIBUTOR SEALS**

Mercury seals will not be permitted. Ease of seal replacement will be considered in the design to ensure continuity of operation.

### **91.7 UNIT SIZING**

Required volumes of filter media will be based upon pilot testing with the particular wastewater or any of the various empirical design equations that have been verified through actual full-scale experience. Such calculations will be submitted if pilot testing is not utilized. Pilot testing is recommended to verify performance predictions based upon the various design equations, particularly when significant amounts of industrial wastes are present.

Trickling filter design will consider peak organic load conditions including the oxygen demands due to biosolids processing sidestreams (i.e. heat treatment supernatant, vacuum filtrate, anaerobic digester supernatant, etc.) due to high concentrations of BOD<sub>5</sub> and TKN associated with such flows. The volume of media determined from either pilot plant studies or use of acceptable design equations will be based upon the design maximum day BOD<sub>5</sub> organic loading rate rather than the design average BOD<sub>5</sub> rate. Refer to Chapter 10, paragraph 12.6.1.5.

## **92. ACTIVATED BIOSOLIDS**

### **92.1 GENERAL**

#### **92.1.1 Applicability**

##### **92.1.1.1 *Biodegradable Wastes***

The activated biosolids process and its various modifications may be used where wastewater is amenable to biological treatment.



#### **92.1.1.2      *Operational Requirement***

This process requires close attention and competent operating supervision, including routine laboratory control. These requirements will be considered when proposing this type of treatment.

#### **92.1.1.3      *Energy Requirements***

This process requires major energy usage to meet aeration demands. Energy costs and potential mandatory emergency public power reduction events in relation to critical water quality conditions will be carefully evaluated. Capability of energy usage phasedown while still maintaining process viability, both under normal and emergency energy availability, will be included in the activated biosolids design.

### **92.1.2      *Specific Process Selection***

The activated biosolids process and its several modifications may be employed to accomplish varied degrees of removal of suspended solids and reduction of carbonaceous and/or nitrogenous oxygen demand. Choice of the process most applicable will be influenced by the degree and consistency of treatment required, type of waste to be treated, proposed plant size, discharge permit effluent quality requirements, anticipated degree of operation and maintenance, and operating and capital costs. All designs will provide for flexibility in operation and will provide for operation in various modes, if feasible.

## **92.2      *PRETREATMENT***

Where primary settling tanks are not used, effective removal or exclusion of grit, debris, excessive oil or grease, and screening of solids will be accomplished prior to the activated biosolids process.

Where primary settling is used, provision will be made for discharging raw wastewater directly to the aeration tanks to facilitate plant start-up and operation during the initial stages of the plant's design life.

## **92.3      *AERATION***

### **92.3.1      *Capacities and Permissible Loadings***

The size of the aeration tank for any particular adaptation of the process will be determined by full-scale experience, pilot plant studies, or rational calculations



based mainly on food to microorganism ratio and mixed liquor suspended solids levels. Other factors, such as size of treatment plant, diurnal load variations, and degree of treatment required, will also be considered. In addition, temperature, alkalinity, pH, and reactor dissolved oxygen will be considered when designing for nitrification.

Calculations will be submitted to justify the basis for design of aeration tank capacity. Calculations using values differing substantially from those in the accompanying table will reference actual operational plants. Mixed liquor suspended solids levels greater than 5000 mg/L may be allowed providing adequate data is submitted showing the aeration and clarification system capable of supporting such levels.

When process design calculations are not submitted, the aeration tank capacities and permissible loadings for the several adaptations of the processes shown in the following table will be used.

#### PERMISSIBLE AERATION TANK CAPACITIES AND LOADINGS

Process	***Aeration Tank		
	Organic Loading	F/M Ratio	MLSS *
	lbs. BOD <sub>5</sub> /d/1000 ft <sup>3</sup> (kg/d/m <sup>3</sup> ) * *	lb. BOD <sub>5</sub> /day per lb. ML VSS * *	
Conventional Step Aeration Complete Mix	40 (0.64)	0.2-0.5	1000-3000
Extended Aeration			
Single Stage Nitrification	15 (0.24)	0.05-0.1	3000-5000

\* MLSS values are dependent upon the solids retention time, surface area provided for sedimentation, and the rate of biosolids return as well as the aeration process.

\* \* Refer to 12.6.1.5.1 for definition of BOD.

\*\*\* Loadings are based on the organic load influent to the aeration tank at plant design average BOD<sub>5</sub>.

### **92.3.2 Arrangement of Aeration Tanks**

#### **a. Dimensions**

The dimensions of each independent mixed liquor aeration tank will be such as to maintain effective mixing and utilization of air.





Ordinarily, liquid depths will not be less than 10 feet (3 m) or more than 30 feet (9 m) except in special design cases. An exception is that oxidation ditches will have a depth of not less than 5.5 feet (1.7 m).

b. Short-circuiting

The shape of the tank, the location of the influent and biosolids return, and the installation of aeration equipment will provide for positive control to prevent short-circuiting through the tank.

**92.3.2.1      *Number of Units***

Total aeration tank volume will be divided among two or more units, capable of independent operation, when required by the appropriate reviewing authority to meet applicable effluent limitations and reliability considerations.

**92.3.2.2      *Inlets and Outlets***

Inlets and outlets for each aeration tank unit will be suitably equipped with valves, gates, stop plates, weirs, or other devices to permit controlling the flow to any unit and to maintain reasonably constant liquid level. The effluent weir for an oxidation ditch will be easily adjustable by mechanical means and will be sized based on the design peak instantaneous flow plus the maximum return biosolids flow. Refer to paragraph 92.4.1. The hydraulic properties of the system will permit the design peak instantaneous flow to be carried with any single aeration tank unit out of service.

**92.3.2.3      *Freeboard***

All aeration tanks will have a freeboard of not less than 24 inches (460 mm). However, if a mechanical surface aerator is used, the freeboard will be not less than 4 feet (910 mm) to protect against windblown spray freezing on walkways, etc.

**92.3.3      *Aeration Equipment***

**92.3.3.1      *General***

Oxygen requirements generally depend on maximum diurnal organic loading (design peak hourly BOD<sub>5</sub> as described in Chapter 10, paragraph



12.6.1.5), degree of treatment, and level of suspended solids concentration to be maintained in the aeration tank mixed liquor. Aeration equipment will be capable of maintaining a minimum of 2.0 mg/L of dissolved oxygen in the mixed liquor at all times and provide thorough mixing of the mixed liquor. In the absence of experimentally determined values, the design oxygen requirements for all activated biosolids processes will be 1.1 lbs.  $O_2$ /lb. design peak hourly  $BOD_5$  applied to the aeration tanks (1.1 kg  $O_2$ /kg design peak hourly  $BOD_5$ ), with the exception of the extended aeration process, for which the value will be 1.5 to include endogenous respiration requirements.

Nitrification will occur at most plants in New Mexico unless the process is operated at very low solids retention time (less than 3 days), therefore, the oxygen requirement for oxidizing ammonia will be added to the above requirement for carbonaceous  $BOD_5$  removal and endogenous respiration requirements.

The nitrogenous oxygen demand (NOD) will be taken as 4.6 times the diurnal peak hourly TKN content of the influent. In addition, the oxygen demands due to recycle flows (i.e., heat treatment supernatant, vacuum filtrate, elutriates, etc.) will be considered due to the high concentrations of  $BOD_5$  and TKN associated with such flows. Careful consideration will be given to maximizing oxygen utilization per unit of power input.

### **92.3.3.2      *Diffused Air Systems***

The design of the diffused air system to provide the oxygen requirements will be done by either of the two methods described below in (a) and (b), augmented as required by consideration of items (c) through (h)

- a. Having determined the oxygen requirements per paragraph 92.3.3.1, air requirements for a diffused air system will be determined by use of any of the well-known equations incorporating such factors as
  1. Tank depth;
  2. Alpha factor of waste;
  3. Beta factor of waste;
  4. Certified aeration device transfer efficiency;
  5. Minimum aeration tank dissolved oxygen concentration;
  6. Critical wastewater temperature; and
  7. Altitude of plant.



In the absence of experimentally determined alpha and beta factors, wastewater transfer efficiency will be assumed to be not greater than 50% of clean water efficiency for plants treating primarily (90% or greater) domestic wastewater. Treatment plants where the waste contains higher percentages of industrial wastes will use a correspondingly lower percentage of clean water efficiency and will have calculations submitted to justify such a percentage. The design transfer efficiency will be included in the specifications.

- b. Normal air requirements for all activated biosolids processes except extended aeration (assuming equipment capable of transmitting to the mixed liquor the amount of oxygen required in paragraph 92.3.3.1) will be considered to be 1500 cu. ft. at standard conditions of pressure, temperature, and humidity per pound of BOD<sub>5</sub> tank loading (94 m<sup>3</sup>/kg of BOD<sub>5</sub>). For the extended aeration process the value will be 2050 cu. ft. per pound of BOD<sub>5</sub> (128 m<sup>3</sup>/kg of BOD<sub>5</sub>)
- c. To the air requirements calculated above, will be added air required for channels, pumps, aerobic digesters, filtrate, and supernatant or other air-use demand.
- d. The specified capacity of blowers or air compressors, particularly centrifugal blowers, will take into account that the air intake temperature may reach 115° F (46° C) or higher and the pressure may be less than normal. The specified capacity of the motor drive will also take into account that the intake air may be 20°F (-6.7°C) or less and may require oversizing of the motor or a means of reducing the rate of air delivery to prevent overheating or damage to the motor.
- e. The blowers will be provided in multiple units, so arranged and in such capacities as to meet the maximum air demand with the single largest unit out of service. The design will also provide for varying the volume of air delivered in proportion to the load demand of the plant. Aeration equipment will be easily adjustable in increments and will maintain solids suspension within



these limits. Sufficient flexibility will be provided to prevent over-aeration at startup and night-time flows.

- f. Air piping systems will be designed such that total head loss from blower outlet (or silencer outlet where used) to the diffuser inlet does not exceed 0.5 psi (3.4 kPa) at average operating conditions.

The spacing of diffusers will be in accordance with the oxygen requirements through the length of the channel or tank, and will be designed to facilitate adjustment of their spacing without major revisions to air header piping.

- g. Individual assembly units of diffusers will be equipped with control valves, preferably with indicator markings, for throttling or for complete shutoff. Diffusers in any single assembly will have substantially uniform pressure loss.
- h. Air filters will be provided in numbers, arrangements, and capacities to furnish at all times an air supply sufficiently free from dust to prevent damage to blowers and clogging of the diffuser system used.

### **92.3.3.3      *Mechanical Aeration Systems***

- a. *Oxygen Transfer Performance*

The mechanism and drive unit will be designed for the expected conditions in the aeration tank in terms of the power performance. Certified testing will be provided to verify mechanical aerator performance. Refer to applicable provisions of paragraph 92.3.3.2. In the absence of specific design information, the oxygen requirements will be calculated using a transfer rate not to exceed 3 lbs. of oxygen per horsepower per hour (1.22 kg O<sub>2</sub>/kW hr.) in clean water under standard test conditions. Design transfer efficiencies will be included in the specifications.

- b. *Design Requirements*

The design requirements of a mechanical aeration system will accomplish the following:



1. Maintain a minimum of 2.0 mg/L of dissolved oxygen in the mixed liquor at all times throughout the tank or basin.
2. Maintain all biological solids in suspension (for a horizontally mixed aeration tank system an average velocity of 1 foot per second [0.3 m/sec] will be maintained).
3. Meet maximum oxygen demand and maintain process performance with the largest unit out of service.
4. Provide for varying the amount of oxygen transferred in proportion to the load demand on the plant.
5. Provide that motors, gear housing, bearings, grease fittings, etc., be easily accessible and protected from inundation and spray as necessary for proper functioning of the unit.

*c. Winter Protection*

Where extended cold weather conditions occur, the aerator mechanism and associated structure will be protected from freezing due to splashing. Due to high heat loss, subsequent treatment units will be protected from freezing.

## 92.4 RETURN BIOSOLIDS EQUIPMENT

### 92.4.1 Return Biosolids Rate

The minimum permissible return biosolids rate of withdrawal from the final settling tank is a function of the concentration of suspended solids in the mixed liquor entering it, the biosolids volume index of these solids, and the length of time these solids are retained in the settling tank. Since undue retention of solids in the final settling tanks may be deleterious to both the aeration and sedimentation phases of the activated biosolids process, the rate of biosolids return expressed as a percentage of the design average flow of wastewater will generally be variable between the limits set forth as follows.

Variable speed RAS pumps will be sized for 30-100% of influent flow for all plants.



The rate of biosolids return will be varied by means of variable speed motors, drives, or timers (small plants) to pump biosolids at the above rates.

#### **92.4.2 Return Biosolids and WAS Pumps**

If motor drive return biosolids pumps are used, the maximum return biosolids capacity will be obtained with the largest pump out of service. A positive head will be provided on pump suctions. Pumps will have at least 3 inch (80 mm) suction and discharge openings. Care will be taken to account for positive suction head when calculating head requirements for RAS and WAS pumps.

If air lifts are used for returning biosolids from each settling tank hopper, no standby unit will be required provided the design of the air lifts facilitate their rapid and easy cleaning and provided other suitable standby measures are provided. Air lifts will be at least 3 inches (80 mm) in diameter.

#### **92.4.3 Return Biosolids Piping**

Discharge piping will be at least 4 inches (100 mm) in diameter and will be designed to maintain a velocity of not less than 2 feet per second (0.6 m/s) when return biosolids facilities are operating at normal return biosolids rates. Suitable devices for observing, sampling, and controlling return activated biosolids flow from each settling tank hopper will be provided, as outlined in Chapter 70, paragraph 73.3.4.

#### **92.4.4 Waste Biosolids Facilities**

Waste biosolids control facilities will have a capacity of at least 25% of the design average rate of wastewater flow and function satisfactorily at rates of 0.5% of design average wastewater flow or a minimum of 10 gallons per minute (0.6 L/s), whichever is larger. Means for observing, measuring, sampling, and controlling waste activated biosolids flow will be provided. Waste biosolids will be thickened prior to being discharged to an anaerobic digester. Waste biosolids will not be discharged into a primary clarifier, if the biosolids from the primary is being pumped directly to an anaerobic digester, without thickening. Gravity thickeners are not recommended for thickening of waste activated biosolids prior to discharging in an anaerobic digester.



## **92.5 MEASURING DEVICES**

Devices will be installed in all plants for indicating flow rates of raw wastewater or primary effluent, return biosolids, and air to each tank unit. For plants designed for design average wastewater flows of 1 MGD (3785 m<sup>3</sup>/d) or more, these devices will totalize and record as well as indicate flows. Where the design provides for all return biosolids to be mixed with the raw wastewater (or primary effluent) at one location, then the mixed liquor flow rate to each aeration unit will be measured.

## **93. OTHER BIOLOGICAL SYSTEMS**

### **93.1 GENERAL**

Biological treatment processes not included in these standards may be considered in accordance with Chapter 50, Section 53.2.



## CHAPTER 100

### DISINFECTION

#### 101. GENERAL

Disinfection of the effluent will be provided as necessary to meet applicable standards. The design may consider meeting both the bacterial standards and the disinfectant residual limit in the effluent. The disinfection process will be selected after due consideration of waste characteristics, type of treatment process provided prior to disinfection, waste flow rates, pH of waste, disinfectant demand rates, current technology application, cost of equipment and chemicals, power cost, and maintenance requirements. Chlorine and ultraviolet light are the most commonly used disinfecting agents for treated wastewater effluent disinfection. The forms of chlorine most often used are gaseous chlorine, sodium hypochlorite solution at nominal solution strengths of 5-11%, dilute (<1%) sodium hypochlorite solution generated on-site from electrolysis of sodium chloride brine, and dry calcium hypochlorite. The two basic forms of ultraviolet light disinfection systems are those using medium pressure (wide spectrum) lamps and those using low pressure (focused spectrum) lamps. Other disinfectants, including chlorine dioxide, ozone, or peracetic acid, may be accepted by the reviewing authority in individual cases. If chlorine is utilized, it may be necessary to dechlorinate if the residual level in the effluent exceeds effluent limitations or would impair the natural aquatic habitat of the receiving stream. Where a disinfection process other than chlorine or ultraviolet light is proposed, supporting data from pilot plant installations or similar full scale installations will be required as a basis for the design of the system. Refer to paragraph 53.2.

#### 102. CHLORINE DISINFECTION

##### 102.1 TYPE

Chlorine is available for disinfection in gas, liquid (hypochlorite solution), and pellet (hypochlorite tablet) form. The type of chlorine should be carefully evaluated during the facility planning process. The use of chlorine gas or liquid will be most dependent on the size of the facility and the chlorine dose required. Large quantities of chlorine, such as are contained in ton cylinders and tank cars, can present a considerable hazard to plant personnel and to the surrounding area should such containers develop leaks. Both monetary and the potential public exposure to chlorine should be considered when making the final determination. Since 1989, specific regulatory initiatives have been implemented to address public safety concerns associated with handling and storage of gaseous chlorine. In those jurisdictions where local building code enforcement





officials recognize the Uniform Fire Code (UFC), Article 80 of the Code specifies required safety features for chlorine storage facilities. Paragraph 102.5.1 of this Section provides a synopsis of principal safety features required by UFC Article 80 for gaseous chlorine storage facilities that store in excess of 90 lbs. of gas on site. In addition, for those facilities that store > 2,500 lbs. of gaseous chlorine on site (or > 500 lbs. of sulfur dioxide if used for dechlorination), the U.S. Environmental Protection Agency has developed requirements for developing and implementing Risk Management Plans (RMP's) to mitigate hazards and damages that could otherwise occur from accidental releases of hazardous gases. Besides establishing detailed documentation for the design basis, applicable codes and standards, and materials of construction for a facilities chlorine storage and handling equipment, RMP's also provide detailed descriptions of procedures to be followed at the facility in case of an accidental release, along with provisions for routine training and practice of emergency response procedures with responsible authorities at the facility. The reader is referred to 40 CFR Part 63 and Part 1400 for a detailed description of required elements to implement and administer and RMP.

## 102.2 DOSAGE

For disinfection, the capacity will be adequate to produce an effluent that will meet the applicable bacterial limits specified by the regulatory agency for that installation. Required disinfection capacity will vary, depending on the uses and points of application of the disinfection chemical. The chlorination system will be designed on a rational basis and calculations justifying the equipment sizing and number of units will be submitted for the whole operating range of flow rates for the type of control to be used. System design considerations will include the controlling wastewater flow meter (sensitivity and location), telemetering equipment and chlorination controls. For normal domestic wastewater, the following may be used as a guide in sizing chlorination facilities.

<u>Type of Treatment</u>	<u>Dosage</u>
Trickling filter plant effluent	10 mg/L
Activated sludge plant effluent	8 mg/L
Tertiary filtration effluent	6 mg/L
Biological nutrient removal plant effluent*	6 mg/L

\*Conservatively designed BNR plants producing effluent with very low concentrations of ammonia may experience erratic chlorine disinfections performance due to the lack of sufficient ammonia to form monochloramine. The design of disinfection facilities for such plants will usually require a means to add



sufficient ammonia back into the effluent prior to chlorination, such as bypassing flows from upstream ammonia removal processes / treatment units, or use of supplemental ammonia feed systems. Breakpoint chlorination, in even the most highly treated effluents, is rarely practiced.

### **102.3 CONTAINERS**

#### **102.3.1 Cylinders**

150 pound (68 kg) cylinders are typically used where chlorine gas consumption is less than 150 pounds per day (68 kg/day). Cylinders should be stored in an upright position with adequate support brackets and chains at 2/3 of cylinder height for each cylinder.

#### **102.3.2 Ton Containers**

The use of one-ton (909 kg) containers should be considered where the average daily chlorine consumption is over 150 pounds (68 kg).

#### **102.3.3 Tank Cars**

At large installations, the use of tank cars, generally accompanied by evaporators, may be considered. Areawide public safety will be evaluated. No interruption of chlorination will be permitted during tank car switching. The tank car being used for the chlorine supply will be located on a dead end, level track that is a private siding. The tank car will be protected from accidental bumping by other railway cars by a locked derail device or a closed locked switch or both. The area will be clearly posted "DANGER-CHLORINE". The tank car will be secured by adequate fencing with gates provided with locks for personnel and rail access. The tank car site will be provided with a suitable operating platform at the unloading point for easy access to the protective housing or the tank car for connection of flexible feedlines and valve operations.

#### **102.3.4 Liquid Hypochlorite Solutions**

Commercially available solution strengths for sodium hypochlorite include 5% and 10-11%. Sodium hypochlorite can be fed as an undiluted i.e., neat solution from pre-packaged 25 or 50-gallon containers. For facilities using a large volume of hypochlorite solution and for which handling multiple pre-packaged containers would be impractical, bulk storage facilities should be provided. Bulk storage containers for hypochlorite solutions will be of sturdy, non-metallic lined construction and will be provided with secure tank tops and pressure relief and



overflow piping. Containers should be sized to store 150% of the maximum volume of bulk solution that will be delivered at one time. Storage tanks should be either located or vented outside. Provision will be made for adequate protection from light and extreme temperatures. Tanks will be located where leakage will not cause corrosion or damage to other equipment. A means of secondary containment will be provided to contain spills and facilitate cleanup. Due to deterioration of hypochlorite solutions over time, particularly for solution strengths of 10-11%, it is recommended that containers not be sized to hold more than one month's needs. At larger facilities and locations where delivery is not a problem, it may be desirable to limit on-site storage to one week. Refer to Section 57.

### **102.3.5 On-site Generated Sodium Hypochlorite Solution**

Dilute (<1%) solutions of sodium hypochlorite for disinfection may be prepared on-site through electrolysis of saturated sodium chloride brine. Commercially available on-site generation systems nominally include brine make-up and feed system, water softening systems to pre-treat brine make-up water and process dilution water, a battery of 2 or more parallel electrolytic cells through which sodium chloride brine passes to generate hydrogen gas and sodium hypochlorite solution, bulk storage tank for sodium hypochlorite product, metering pumps or similar system to feed hypochlorite solution at a controlled rate at the point of use, and power supply and control systems that supply and regulate the amount of electricity applied to each generation cell. Normally, all of these system components are purchased from a single source of supply that manufactures on-site hypochlorite generation equipment to assure that all components work as a unified system.

On-site hypochlorite generation systems are usually rated in terms of lbs. per day of sodium hypochlorite product. On-site hypochlorite generation systems should be sized to produce the maximum required mass of hypochlorite disinfectant with one of the system's multiple electrolytic cells being out of service for maintenance and cleaning. As these systems require a dependable supply of electric power in order to function, facilities that use on-site generation and that are expected to continue receiving effluent flow in the event of a sustained power outage will need to have sufficient standby power generation capacity to run the system during the outage. On-site hypochlorite generation systems roughly consume 3 lbs of sodium chloride brine for every lb. of sodium hypochlorite oxidant produced. On a per lb. basis, hypochlorite produced by on-site generation is more costly than gaseous chlorine. On-site generation systems however do not require the gas safety equipment and scrubbers otherwise



required under UFC Article 80 for gaseous chlorine nor are on-site generation facilities required to develop and implement RMP's. The elimination of the need to comply with these safety regulations for gaseous chlorine may make on-site generation systems a more cost-effective way to disinfect wastewater.

### **102.3.6 Dry Hypochlorite Compounds**

Dry hypochlorite compounds should be kept in tightly closed containers and stored in a cool, dry location. Some means of dust control should be considered, depending on the size of the facility and the quantity of compound used. Refer to Section 57.

## **102.4 EQUIPMENT**

### **102.4.1 Scales**

Scales for weighing cylinders and containers will be provided at all plants using chlorine gas. At large plants, scales of the indicating and recording type are recommended. At least a platform scale will be provided. Scales will be of corrosion-resistant material.

### **102.4.2 Evaporators**

Where manifolding of several cylinders or ton containers will be required to evaporate sufficient chlorine, consideration should be given to the installation of evaporators to produce the quantity of gas required.

### **102.4.3 Mixing**

The disinfectant will be positively mixed as rapidly as possible, with a complete mix being effected in 3 seconds. This may be accomplished by either the use of turbulent flow regime or a mechanical flash mixer. Mechanical flash mixers may include traditional propeller mixer units suspended from above the tank as well as submersible, open impeller mixing units that pull gaseous chlorine or hypochlorite solution under vacuum into the impeller which rapidly disperse the disinfectant into the wastewater.

### **102.4.4 Contact Period and Tank**

For a chlorination system, a minimum contact period of 15 minutes at design peak hourly flow or maximum rate or pumpage will be provided after thorough mixing. The 15-minute time period assures sufficient time for the disinfectant to



destroy pathogenic organisms via oxidation. For evaluation of existing chlorine contact tanks, field tracer studies should be done to assure adequate contact time. The chlorine contact tank will be constructed so as to reduce short-circuiting of flow to a practical minimum. Tanks not provided with continuous mixing will be provided with “over-and-under” or “end-around” baffling to minimize short-circuiting. The tank should be designed to facilitate maintenance and cleaning without reducing effectiveness of disinfection. Duplicate tanks, and appropriately placed drains will be provided. Consideration should be given to providing skimming devices on all contact tanks. Covered tanks are discouraged.

#### **102.4.5 Piping and Connections**

Piping systems should be as simple as possible, specifically selected and manufactured to be suitable for gaseous chlorine service, with a minimum number of joints. Piping should be well supported and protected against temperature extremes. Due to the corrosiveness of wet chlorine, all lines designated to handle dry chlorine gas will be protected from the entrance of water. Water added to chlorine results in a corrosive attack. Even minute traces of water added to chlorine gas results in a corrosive attack. Low pressure lines made of hard rubber, saran-lined, rubber-lined, polyethylene, polyvinylchloride (PVC), or other approved materials are satisfactory for wet chlorine or aqueous solutions of chlorine. The chlorine system piping will be color coded and labeled to distinguish to from other plant piping. Refer to paragraph 54.5.

Where sulfur dioxide is used, the piping and fittings for chlorine and sulfur dioxide systems will be designed so that interconnection between the two systems cannot occur. Disinfectant systems that feed pre-mixed sodium hypochlorite solution will have piping that has been specifically designed to vent off gases that escape from solution. Failure to accommodate relief of gases may create hazardous conditions that cause piping system ruptures and explosions. Suction lines to solution metering pumps should be sloped to allow these gases to escape back to the storage container. Ideally, feed systems for pre-mixed hypochlorite solution should be sized so that there is always some flow of solution through the system that will help mitigate the formation of off-gases in the piping.

#### **102.4.6 Standby Equipment and Spare Parts**

Standby equipment of sufficient capacity should be available to replace the largest unit of the gaseous chlorine or hypochlorite make-up and feed system during shutdowns. Spare parts will be available for all disinfection system equipment components to replace parts which are subject to wear and breakage.



#### **102.4.7 Chlorinator Water Supply**

An ample supply of water will be available for operating the chlorinator. Where a booster pump is required, duplicate equipment should be provided, and, when necessary, standby power as well. Protection of a potable water supply will conform to the requirements of paragraph 56.2. Adequately filtered plant effluent should be considered for use in the chlorinator.

#### **102.4.8 Leak Detection and Controls**

A bottle of 56 percent ammonium hydroxide solution will be available for detecting chlorine leaks. Where ton containers (909 kg) or tank cars are used, a leak repair kit approved by the Chlorine Institute will be provided. Consideration should be given to the provision of caustic soda solution reaction tanks for absorbing the contents of leaking one-ton (909 kg) containers where such containers are in use. Consideration should be given to the installation of automatic gas detection and related alarm equipment.

#### **102.4.9 Feed Pumps for Hypochlorite Solution**

Chemical metering pumps for feeding hypochlorite disinfectant solutions will be adequately sized to feed the maximum daily demand of solution with the largest metering pump out of service for maintenance. Materials of construction for the pump components in contact with hypochlorite will be specifically designed for chemical resistance to the solution. In systems that use a 4-20 milliamp control signal or similar method to automatically regulate metering pump discharge rate, specific attention should be given to assuring that the pump's speed control system has adequate turndown capacity to obtain accurate feed rates at minimum demands for disinfectant solution.

### **102.5 HOUSING**

#### **102.5.1 Feed and Storage Rooms**

If gas chlorination equipment or chlorine cylinders are to be in a building used for other purposes, a gas-tight room will separate this equipment from any other portion of the building. Floor drains from the chlorine room should not be connected to floor drains from other rooms. Doors to this room will open only to the outside of the building, and will be equipped with panic hardware. Rooms will be at ground level and should permit easy access to all equipment. Storage



areas for 1-ton (909 kg) cylinders should be separates from the feed area. In addition, the storage area will have designated areas for “full” and “empty” cylinders. Chlorination equipment should be situated as close to the application point as reasonably possible. For additional safety considerations, refer to section 57. In those communities in which UFC requirements are recognized by local building code enforcement officials, Article 80 of the Code specifies certain minimum features to be included in the design of gaseous chlorine storage facilities. These features include but are not limited to:

- Scrubber systems sized to treat the release of 150% of the contents of the largest container of chlorine in service
- Fire sprinkler system for the building in which gaseous chlorine is stored
- Sump pump to collect discharge from sprinkler system
- Fire alarm and chlorine gas detector alarm
- Standby power for all equipment associated with chlorine feed system including the scrubber system and circuits that power the monitoring and alarm equipment.

#### **102.5.2 Inspection Window**

A clear glass, gas-tight, window will be installed in an exterior door or interior wall of the chlorinator room to permit the units to be viewed without entering the room.

#### **102.5.3 Heat**

Rooms containing disinfection equipment will be provided with a means of heating so that a temperature of at least 60°F (16°C) can be maintained. The room should be protected from excess heat. Cylinders will be kept at essentially room temperature. If liquid hypochlorite solution is used, the containers may be located in an unheated area.

#### **102.5.4 Ventilation**

With chlorination systems, forced, mechanical ventilation will be installed which will provide one complete fresh air change per minute when the room is occupied. The entrance to the air exhaust duct from the room will be near the floor. The point of discharge will be so located as not to contaminate the air inlet to any building or present a hazard at the access to the chlorinator room or other inhabited areas. Air inlets will be so located as to provide cross ventilation with air and at such temperature that will not adversely affect the chlorination equipment. The outside air inlet will be at least three feet above grade. The vent hose from the chlorinator will discharge to the outside atmosphere above grade.





Where public exposure may be extensive, scrubbers may be required on ventilation discharge.

#### **102.5.5 Electrical Controls**

Switches for fans and lights will be outside of the room at the entrance. A labeled signal light indicating fan operations should be provided at each entrance, if the fan can be controlled from more than one point.

#### **102.5.6 Protective and Respiratory Gear**

Respiratory air-pac protection equipment, meeting the requirements of the National Institute for Occupational Safety and Health (NIOSH), will be available where chlorine gas is handled, and will be stored at a convenient location, but not inside any room where chlorine is used or stored. Instructions for using the equipment will be posted. The units will use compressed air, have at least 30-minute capacity and be compatible with units used by the fire department responsible for the plant.

### **102.6 SAMPLING AND CONTROL**

#### **102.6.1 Sampling**

Facilities will be included for sampling disinfected effluence after the contact chamber as monitoring requirements warrant. In large installations, or where stream conditions warrant, provisions should be made of continuous monitoring of effluent chlorine residual.

#### **102.6.2 Testing and Control**

Equipment will be provided for measuring chlorine residual using accepted test procedures. The installation of demonstrated effective facilities for automatic chlorine residual analysis, recording, and proportioning systems should be considered at all large installations. Equipment will also be provided for measuring fecal coliform organisms using accepted test procedures as required by the regulatory agency.

## **103. DECHLORINATION**

### **103.1 TYPES**

Dechlorination of wastewater effluent may be necessary to reduce the toxicity due to chlorine residuals. The most common dechlorination chemicals are sulfur





compounds, particularly sulfur dioxide gas or aqueous solutions of sulfite or bisulfite. Pellet dechlorination systems are also available for small facilities. The type of dechlorination system should be carefully selected considering criteria including the following: type of chemical storage required, amount of chemical needed, ease of operation, compatibility with existing equipment, and safety.

### 103.2 DOSAGE

The dosage of dechlorination chemical should depend on the residual chlorine in the effluent, the final residual chlorine limit, and the particular form of the dechlorinating chemical used. The most common dechlorinating agent is sulfite prepared from gaseous sulfur dioxide. The following forms of the compound are commonly used and yield sulfite ( $\text{SO}_2$ ) when dissolved in water.

<u>Dechlorination Chemical</u>	<u>Theoretical mg/L Required to Neutralize 1 mg/L <math>\text{CL}_2</math></u>
Sulfur dioxide (gas)	0.9
Sodium meta bisulfite (solution)	1.34
Sodium bisulfate (solution)	1.46

Theoretical values may be used for initial approximation, to size feed equipment with the consideration that under good mixing conditions, 10% excess dechlorination chemical is required above theoretical values. Excess sulfur dioxide may consume oxygen at a maximum of 1.0 mg dissolved oxygen for every 4 mg  $\text{SO}_2$ . The liquid solutions come in various strengths. These solutions may need to be further diluted to provide the proper dose of sulfite.

### 103.3 CONTAINERS

Depending on the chemical selected for dechlorination, the storage containers will vary from gas cylinders, liquid in 50 gallon (190 L) drums or dry compounds. Dilution tanks and mixing tanks will be necessary when using dry compounds and may be necessary when using liquid compounds to deliver the proper dosage. Solution containers should be covered to prevent evaporation and spills.

### 103.4 FEED EQUIPMENT, MIXING, AND CONTACT REQUIREMENTS

#### 103.4.1 Equipment

In general, the same type of feeding equipment used for chlorine gas may be used with minor modifications for sulfur dioxide gas. However, the manufacturer should be contacted for specific equipment recommendations. No equipment system should be designed to allow for alternate feed of gaseous chlorine and



sulfur dioxide even if only on a temporary basis. The common type of dechlorination feed equipment utilizing sulfur compounds include vacuum solution feed of sulfur dioxide gas and a positive displacement pump for aqueous solutions of sulfite or bisulfite. The selection of the type of feed equipment utilizing sulfur compounds will include consideration of the operator's safety and overall public safety relative to the wastewater treatment plant's proximity to populated areas and the security of gas cylinder storage. The selection and design of sulfur dioxide feeding equipment will take into account that the gas re-liquefies quite easily. Special precaution must be taken when using ton (909 kg) containers to prevent re-liquefaction. Specially designed electric heating blankets are commercially available for sulfur dioxide ton cylinders that may be used to control re-liquefaction. Where necessary to meet the operating ranges, multiple units will be provided for adequate peak capacity and to provide a sufficiently low feed rate on turn down to avoid depletion of the dissolved oxygen concentrations in the receiving waters.

#### **103.4.2 Mixing Requirements**

The dechlorination reaction with free or combined chlorine will generally occur within 15-20 seconds. The dechlorination chemical should be introduced at a point in the process where the hydraulic turbulence is adequate to assure thorough and complete mixing. If no such point exists, mechanical mixing will be provided. The high solubility of SO<sub>2</sub> prevents it from escaping during turbulence.

#### **103.4.3 Contact Time**

A minimum of 30 seconds for mixing and contact time will be provided at the design peak hourly flow or maximum rate of pumpage. A suitable sampling point will be provided downstream of the contact zone. Consideration will be given to a means of reaeration to assure maintenance of an acceptable dissolved oxygen concentration in the stream following sulfonation.

#### **103.4.4 Standby Equipment and Spare Parts**

The same requirements apply as for chlorination systems. See paragraph 102.4.7.

#### **103.4.5 Sulfonator Water Supply**

The same requirements apply as for chlorination systems. See paragraph 102.4.7.



## **103.5 HOUSING REQUIREMENTS**

### **103.5.1 Feed and Storage Rooms**

The requirements for housing SO<sub>2</sub> gas equipment will follow the same guidelines as used for chlorine gas. Refer to paragraph 102.5 for specific details.

When using solutions of the dechlorinating compounds, the solutions may be stored in a room that meets the safety and handling requirements set forth in Section 57. The mixing, storage, and solution delivery areas must be designed to contain or route solution spillage or leakage away from traffic areas to an appropriate containment unit.

### **103.5.2 Protective and Respiratory Gear**

The respiratory air-pac protection equipment is the same as for chlorine. See paragraph 102.5.6. Leak repair kits of the type used for chlorine gas that are equipped with gasket material suitable for service with sulfur dioxide gas may be used. (Refer to The Compressed Gas Association Publication CGA G-3-1995, "Sulfur Dioxide") For additional safety considerations, see Section 57.

## **103.6 SAMPLING AND CONTROLLING**

### **103.6.1 Sampling**

Facilities will be included for sampling the dechlorinated effluent for residual chlorine. Provisions will be made to monitor for dissolved oxygen concentration after sulfonation when required by the regulatory agency.

### **103.6.2 Testing and Control**

Provision will be made for manual or automatic control of sulfonator feed rates based on chlorine residual measurement or flow.

## **104. ULTRAVIOLET DISINFECTION**

Ultraviolet (UV) disinfection works on the principle of using UV radiation at a nominal wavelength of 254 nanometers to disrupt the DNA of pathogenic organisms in wastewater. As of the Year 2001, there were over a dozen successfully operating UV disinfection systems at New Mexico wastewater treatment plants. Expected performance of the UV system will be based upon experience at similar full-scale installations or



thoroughly documented prototype testing with the particular wastewater. Critical parameters for UV systems are dependent upon manufacturers' design, lamp selection, tube materials, ballasts, configuration, control systems, and associated appurtenances. Submittal of representative effluent for chemical analysis by the UV system manufacturer is strongly recommended. This analysis will identify the potential for chemical substances in the effluent such as iron and phosphate that could react with UV radiation and form deposits on the lamps that interfere with disinfection. Open channel designs with modular UV lamp assemblies that can be removed from the flow are required. Sufficient lamp assemblies and ballasts will be provided in each channel for disinfection reliability and to ensure uninterrupted service during tube cleaning or other required maintenance.

Operator safety and provisions for tube cleaning will also be considered. The hydraulic properties of the system will be designed to simulate plug flow conditions under the full range of expected effluent flows. In addition, a positive means of water level control throughout the range of expected flows must be provided to achieve the necessary exposure time and to assure adequate submergence of the lamps for cooling. Also refer to paragraphs 54.2 and 54.3. This process should be limited to a high quality effluent having at least 65% ultraviolet radiation transmittance at 254 nanometers wave length, and BOD and suspended solids concentration *no greater than 30 mg/l at any time*. As a general guide in system sizing for an activated sludge effluent with the preceding characteristics at the design peak hourly flow, a UV radiation dosage not less than 30,000 $\mu$ Wsec/cm<sup>2</sup> may be used after adjustments for maximum tube fouling, lamp output reduction after 8760 hours of operation, and other energy absorption losses. UV disinfection facilities that are expected to continue receiving effluent flow in the event of a sustained power outage will be provided with standby power generation systems. Treatment plants that use UV disinfection but also have effluent reuse systems will have a separate chlorination system for disinfection of effluent that is used in-plant for wash-down, pump seal water, on-site or off-site reuse applications, as well as for sludge bulking control in upstream activated sludge treatment processes.

## 105. OZONE

Ozone systems for disinfection should be evaluated on a case-by-case basis. Design standards, operating data, and experience for this process are not well established. Therefore, design of these systems should be based upon experience at similar full-scale installations or thoroughly documented prototype testing with the particular wastewater.



## CHAPTER 120

### SEPTAGE HANDLING

#### 120. GENERAL

Public Wastewater Treatment Facilities that accept septage need dedicated facilities to handle these flows. Septage includes not only domestic wastewater but also restaurant grease traps and possibly industrial wastes.

#### 121. PURPOSE

Septage wastes generally have extremely high BOD<sub>5</sub> and TSS concentrations and varying pH levels. Respective typical values for BOD<sub>5</sub> and TSS are 6000 and 15,000 mg/L. Accordingly, if not properly accounted for in the biological process, the septage will either pass through the facility with little or no treatment or poison the biological process. Grease, oils and fats are not typically decomposed in either the fixed film or aeration biological processes. Therefore these wastes will be accounted for in a separate manner from main wastewater flows.

##### 121.1 SEPTAGE TREATMENT

Septage treatment may be handled in one of two ways:

- a. Separately designed facilities for septage.
- b. Combined treatment, with separate handling, including additional treatment steps or elements for septage.

Either option will have, as a minimum, the elements outlined under Section 122 following.

See:

- a. EPA's "Technology Transfer Handbook—Septage Treatment and Disposal," Chapters 3, 4, 6 & 7 - October 1984.
- b. WEF's "Manual of Practice No. 24," 1997.

#### 122. ELEMENTS OF DESIGN

Design of the treatment plant processes will account for septage loading as a part of the complete design. The design criteria used to provide for septage receipt will be listed on



the plans. Loading assumptions and design criteria for septage receiving will be indicated separately, under a septage heading, in addition to the main loading assumptions, and identification of location for introduction into the main processes will be indicated.

### **122.1 ODOR CONTROL**

Septage is extremely odorous waste product. Provisions for controlling these odors is dependent on the location of the receiving station and potential for development in the vicinity. De-gritting devices, pumps, screenings, grit holding units, dumpsters and other equipment used in the process will be housed. This housing will be equipped with an air scrubber or bio-filter.

### **122.2 UNLOADING STATION**

Location of the station will be positioned with the following considerations:

- a. Users access.
- b. Security (within the facility.)
- c. Located at or near the entrance-works of the treatment facility or at an upstream manhole.
- d. Identification of haulers/ origins.

### **122.3 SEPTAGE MONITORING AND CONTROL**

The facility will have provisions for sampling, and metering of the septage volume, and holding prior to introduction into the plant processes.

#### **122.3.1 Sampling**

Sampling will be performed prior to release of the waste into the treatment facility to allow the operator some assurance that it will not disrupt the biological process. Sampling at a minimum will consist of pH, either automatically or manually.

#### **122.3.2 Metering**

Metering is necessary for the facility to maintain historic records and billing purposes.



### **122.3.3 Flow volume**

Flow volume will be capable of adjustment or shutoff so that it may be withheld or constricted in release to the main treatment process (see Section 122.5).

## **122.4 GREASE, OILS, AND FATS**

If the Wastewater Facility accepts these wastes they will be isolated from the liquid process since very little treatment (reduction) occurs. These wastes will be pumped directly to the digester, along with skimming from the primary clarifiers.

The preferred final disposal is through a rendering facility.

## **122.5 HOLDING TANKS**

Holding tanks are used at a minimum for storage but may also be used for equalization, mixing, and aeration of the septage prior to further treatment. Such holding facilities will also allow a controlled outflow of septage to downstream treatment processes to prevent hydraulic and organic shock loading.

### **122.5.1 Multiple Holding Tanks**

Facility will have multiple holding tanks each sized to accommodate the local haulers capacity requirements.

### **122.5.2 Access**

Facility will have access for maintenance and wash down.

### **122.5.3 Coating**

Facility will have coating to protect from corrosion.

### **122.5.4 Flow Adjustment**

Facility will have the capability for flow adjustment and shutoff.

## **122.6 SCREENING AND GRIT REMOVAL**

If the flow is introduced downstream of the treatment facility entrance works, the septage receiving station will be designed to remove screenings and grit.



## **122.7 OPERATION**

Flow from the septage receiving station to the main treatment processes will be controlled. Larger plants may choose to combine flows at all times. Smaller plants may need throttling valves or other devices to protect the main process treatment from the septage “shock” loading. These devices can be programmed or manually operated to release waste to the treatment plant at times and transfer rates that are not disruptive to the main treatment process.





## CHAPTER 130

### PONDS

#### 130. WASTEWATER TREATMENT PONDS

##### 130.1 GENERAL

This Section deals with three generally used variations of treatment ponds that are used in achieving secondary treatment and settling (or clarification) ponds used for polishing and solids processing. The secondary treatment ponds include facultative ponds, partial-mix aerated ponds, and complete-mix aerated ponds. The treatment ponds discussed in this Section will be used as building blocks to a comprehensive treatment system. Ponds, as discussed herein, are also commonly referred to as lagoons. Ponds used for equalization, percolation, evaporation, and solely for biosolids storage are not discussed.

##### 130.2 DEFINITIONS

###### 130.2.1 Facultative Ponds

Facultative ponds have traditionally been the most common type of pond. Other terms by which they are commonly known include oxidation ponds, sewage ponds, and photosynthetic ponds. The term “facultative” is derived from the pond’s use of both aerobic and anaerobic processes to achieve biological conversion in the water column. Aerated ponds can provide for settling, stabilization, and storage of biomass. Keys to facultative operation are oxygen production by photosynthetic algae, passive aeration by the atmosphere, and a stratified water column with both aerobic and anaerobic activity zones. Algae are necessary for oxygen production, but their presence in the final effluent can be problematic. Facultative ponds can discharge effluent continuously, intermittently, or not at all. Intermittent discharge ponds are large and effluent is discharged several times a year when quality is high. Total-containment ponds can work when water lost to evaporation greatly exceeds rainfall.

###### 130.2.2 Partial-Mix Aerated Ponds

An aerated pond supplies oxygen mainly through mechanical or diffused aeration. Aerated ponds are advantageous because they require less land



area than facultative ponds and can produce a more dependable quality of effluent.

Aerated ponds provide for biological conversion and can provide for settling, stabilization, and storage of biomass. In partial-mix ponds, energy input is sufficient to meet some or all of the ponds oxygen requirements but is insufficient to maintain all of the solids in suspension.

### **130.2.3 Complete-Mix Aerated Ponds**

A complete-mix pond supplies oxygen through mechanical or diffused aeration. Complete-mix ponds provide for influent biodegradable carbon to be converted to biomass and flocculation of the biomass, but do not provide for solids settling, stabilization, or for biosolids storage. Energy input to complete-mix ponds is sufficient to retain all solids in suspension.

### **130.2.4 Settling Ponds**

Settling ponds are dedicated to polishing the wastewater from a secondary treatment process and will be relied on to settle suspended solids, stabilize those solids, and store the resulting biosolids. Biological conversion may occur but will not be relied upon. A settling basin may be facultative or partial-mixed aerated.

### **130.2.5 Biosolids Stabilization**

Stabilization reduces the fraction of solids, deposited at the bottom of a water column, which is biodegradable. In low-turbulence environments, most of the biomass produced in the system, along with the settleable fraction of the nonbiodegradable suspended solids in the influent, will settle in the pond to form bottom deposits or biosolids. Before removal and disposal, the biodegradable solids portion of the biosolids will be reduced to a level where it offers no threat to the disposal environment.

## **130.3 LOCATION**

### **130.3.1 Surface Runoff**

Adequate provision will be made to divert stormwater runoff around the ponds and protect pond embankments from erosion.



### 130.3.2 Ground Water Separation

A minimum separation of 4 feet (1.2m) between the bottom of the pond and the maximum ground water elevation will be maintained.

### 130.3.3 Bedrock Separation

A minimum separation of 10 feet (3.0m) between the pond bottom and any bedrock formation is recommended.

## 130.4 BASIS OF DESIGN

### 130.4.1 Reduction of Biochemical Oxygen Demand

#### 130.4.1.1 Facultative Ponds

Because there is essentially no way to quantitatively control treatment processes in a facultative pond, and because treatment performance can vary widely, facultative ponds will be designed only with extreme caution when discharge limits will be reliably met.

TABLE 130.1

Temperature	Average for All Cells		Primary Cell	
	BOD <sub>5</sub> Loading Range <sup>a</sup>	Minimum Retention Time <sup>b</sup>	Maximum BOD <sub>5</sub> Loading <sup>a</sup>	Minimum Retention Time <sup>b</sup>
Above 15°C	40-80 lbs/ac·d (45-90 kg /ha·d)	90 days	89 lbs/ac·d (100 kg /ha·d)	60 days
Between 0°C & 15°C	20-40 lbs/ac·d (22-45 kg /ha·d)	120 days	67 lbs/ac·d (75 kg/ha·d)	90 days
Below 0°C	10-20 lbs/ac·d (11-22 kg/ha·d)	180 days	35 lbs/ac·d (40 kg/ha·d)	120-180 days

a.) Calculated for the mean operating depth over the primary pond(s). Do not include area of secondary ponds in loading.

b.) Calculated for volume between the 2-foot (610 mm) and maximum operating depth of the entire pond system.



Facultative ponds can be designed using an average BOD<sub>5</sub> loading range and minimum retention time from TABLE 130.1; refer to Chapter 10, Section 12, paragraph 12.6.1.5. The detention time and organic

loading for BOD<sub>5</sub>, along with other design considerations, will be directly related to the climatic conditions, including the duration of the cold weather period (water temperatures less than 5°C). Design variables such as pond depth, number of ponds in treatment process, detention time, and additional treatment processes will be considered with respect to applicable standards for BOD<sub>5</sub>, total suspended solids (TSS), nitrogen, fecal coliform, dissolved oxygen (DO) and pH. Additional storage volume will be considered for settled biosolids, and for ice cover in cold areas.

#### 130.4.1.2 Partial-Mix Aerated Ponds

For the development of partial-mix aerated ponds system design parameters, it is recommended that actual experimental data be used. Removal-rate constants for domestic wastewater, which includes some industrial wastes, other wastes, and partially treated wastewater, will be determined experimentally for the various conditions which might be encountered in the pond system. Further, conversion of a removal-rate constant, to describe treatment conditions at other temperatures, will be based on experimental data.

**TABLE 130.2**

Applied Mixing/Aeration Power	Mixing Regime	k (at 20°C)
Less than 7.5 hp/Mgal 1.5 kW/1000m <sup>3</sup>	Particulate BOD settles out of solution and is stabilized on pond bottom. Only soluble BOD in the water column.	0.2-0.5/day
7.5-15 hp/Mgal 1.5-3 kW/1000m <sup>3</sup>	Most particles settle to pond bottom. Concentration of particles varies throughout pond. Soluble, together with some particulate BOD, requires treatment in water column.	0.3-0.8/day
15-30 hp/Mgal 3-6 kW/1000m <sup>3</sup>	Large solids settle. Uniform concentration of particles is maintained throughout pond. Both soluble and particulate BOD requires treatment in the water column.	0.5-1.5/day
Greater than 30 hp/Mgal 6 kW/1000m <sup>3</sup>	Complete-mix. Solids are suspended uniformly throughout pond. Both solid and soluble BOD requires treatment in water column.	1.5-3.0/day



However, the BOD<sub>5</sub> removal performance of a partial mix aerated pond treating domestic wastewater, may be estimated using EQUATION

130.1, applied in accordance with the anticipated mixing regime listed in TABLE 130.2. EQUATION 130.1 will be applied separately to each aerated cell. The amount of mixing power to be applied will usually depend on how much biosolids accumulation is acceptable/desirable.

The removal-rate constant shown in TABLE 130.2 varies with temperature. EQUATION 130.2 can be used to estimate the influence of temperature on the removal-rate constant, and the pond water temperature can be estimated using EQUATION 130.3.

The effect of any return biosolids will be considered when determining the strength of influent wastewater. Also, additional storage volume will be considered for settled biosolids, and for ice cover in cold areas.

Oxygen requirements generally will depend on the average BOD<sub>5</sub> loading and the degree of treatment desired. Because an anaerobic activity zone is usually desirable for solids stabilization in the pond bottom, aeration equipment will be capable of maintaining a minimum dissolved oxygen level of 2 mg/L in the ponds' upper levels at all times. The depth of the aerated zone may vary, but will not be less than 40% of the overall pond depth. See paragraph 92.33 for details on aeration equipment. Suitable protection from weather will be provided for electrical controls.

#### **130.4.1.3 Complete-Mix Ponds**

The hydraulic retention time for a complete mix pond will not be less than 1.5 days and not exceed 3 days. The same procedure for estimating the performance of a partial mix aerated pond, presented in paragraph 130.4.1.2, can be used for the design of a complete-mix pond. The amount of mixing power to be applied will depend on the TSS concentration, but will not be less than that shown in TABLE 130.2 for a complete-mix regime.

##### **EQUATION 130.1**

$$S := S_o \cdot \left[ \frac{1}{(1 + k \cdot \theta)} \right]$$

S = effluent BOD<sub>5</sub> (mg/L)  
S<sub>o</sub> = influent BOD<sub>5</sub> (mg/L)  
k = 1<sup>st</sup> order removal-rate constant (1/days)  
θ = hydraulic retention time (days)



#### 130.4.1.4 Settling Ponds

Settling ponds will be designed for solids sedimentation, solids stabilization, and biosolids storage. Since the requirements for solids stabilization and biosolids storage result in air-water surface areas that greatly exceed that required for sedimentation, sedimentation requirements are generally ignored in design. Aeration of settling ponds is encouraged, but at a level that allows all the particulates to settle, per TABLE 130.2. Settling ponds will be designed to minimize algae growth per paragraph 130.6, and to maximize biosolids stabilization per paragraph 130.7.

#### 130.4.2 Industrial Wastes

Consideration will be given to the type and effects of industrial wastes on the treatment process. In many cases it may be necessary to pretreat industrial or other discharges.

##### **EQUATION 130.2**

$$k := k_{20} \cdot 1.036^{T_w - 20}$$

$k$  = reaction rate at temperature  $T_w$  (1/day)

$k_{20}$  = reaction rate at 20°C (1/day)

$T_w$  = temperature of pond water (°C)

Industrial wastes will not be discharged to ponds without assessment of the effects such substances may have upon the treatment process or discharge requirements.

#### 130.4.3 Number of Cells Required

All systems will be designed with piping flexibility to permit isolation of any cell without affecting the transfer and discharge capabilities of the total system. In addition, the ability to discharge the influent waste load to a minimum of 2 cells and/or all primary cells in the system will be provided.

##### **EQUATION 130.3**

$$T_w := \frac{0.5 \cdot A \cdot T_a + Q \cdot T}{0.5 \cdot A + Q}$$

$T_w$  = temperature of pond water (°C)

$T_a$  = ambient air temperature (°C)

$A$  = surface area of pond (m<sup>2</sup>)

$Q$  = wastewater flow rate (m<sup>3</sup>/day)

At a minimum, a wastewater treatment pond system will consist of 3 cells designed to facilitate both series and parallel operations. The maximum size of a pond cell will be 40 acres (16 ha). Two-cell systems may be considered in very small installations.



#### **130.4.4 Facultative Ponds with Controlled-Discharge**

For controlled-discharge systems, the area specified as the primary ponds will be equally divided into two cells. The volume of the third cell (or the sum of the secondary cells' volumes) will, as a minimum, be equal to the volume of the primary cells.

In addition, design will permit for adequate elevation difference between primary and secondary ponds to permit gravity filling of the secondary from the primary. Where this is not feasible, pumping facilities will be provided.

#### **130.4.5 Facultative Ponds with Flow-Through Discharge**

At a minimum, primary cells will provide adequate detention time to maximize BOD<sub>5</sub> removal. Secondary cells will then be provided for additional detention time with depths to 8 feet (2.4m) to facilitate solids reduction. The volume of a secondary pond(s) will be, as a minimum, equal to 50% of the total volume of the primary ponds. Design will also consider recirculation within the system.

#### **130.4.6 Partial-Mix & Complete-Mix Aerated Ponds**

A minimum of 2 aerated ponds, plus a settling pond is required. The polishing cell may be facultative or partial-mix aerated. Aerated cells will be followed by settling ponds with a volume of at least 30% of the total volume of the aerated cells.

#### **130.4.7 Pond Shape**

The shape of all cells will be such that there are no narrow or elongated portions. Round, square or rectangular ponds (length not exceeding three times the width) are considered most desirable. No islands, peninsulas or coves will be permitted. Dikes will be rounded at corners to minimize accumulations of floating materials. Common-wall dike construction, wherever possible, is strongly encouraged.

#### **130.4.8 Pond Hydraulics**

Analysis of performance data from selected aerated and facultative ponds indicates that four cells in series are desirable to give the best BOD removal. Good performance can also be obtained with a smaller number of cells if baffles or dikes are used to optimize the hydraulic characteristics of the system.



Better treatment is obtained when the flow is guided more carefully through the pond. In addition to treatment efficiency, economics and aesthetics play an important role in deciding whether or not baffling is desirable. In general, the more baffling is used, the better are the flow control and treatment efficiency. The lateral spacing and length of the baffle will be specified so that the cross-sectional area of flow is as close to a constant as possible.

Wind generates a circulatory flow in bodies of water. To minimize short-circuiting due to wind, the pond inlet/outlet axis will be aligned perpendicular to the prevailing wind direction, if possible. If this is not possible, baffling can be used to control wind-induced circulation to some extent. In a constant-depth pond, the surface current will be in the direction of the wind, and the return flow will be in the upwind direction along the bottom, aligned perpendicular to the prevailing wind direction.

## **130.5 POND CONSTRUCTION DETAILS**

### **130.5.1 Embankments and Dikes**

#### **130.5.1.1 Material**

Dikes will be constructed of relatively impervious soil and compacted to at least 90% standard proctor density to form a stable structure. Vegetation and other unsuitable materials will be removed from the area where the embankment is to be placed.

#### **130.5.1.2 Top Width**

The minimum dike width will be 8 feet (2.4 m) to permit access for maintenance vehicles.

#### **130.5.1.3 Maximum Slopes**

Inner and outer dike slopes will not be steeper than 1 vertical to 3 horizontal (1:3).

#### **130.5.1.4 Minimum Slopes**

Inner slopes will not be flatter than 1 vertical to 4 horizontal (1:4). Flatter slopes can be specified for larger installations because of wave action but have the disadvantage of added willow areas being





conducive to emergent vegetation. Outer slopes will be sufficient to prevent surface runoff from entering the ponds.

#### **130.5.1.5 Freeboard**

Minimum freeboard will be 3 feet (910 mm), except that for small systems 2 feet (600 mm) may be acceptable.

#### **130.5.1.6 Design Depth**

The minimum operating depth will be sufficient to prevent growth of aquatic plants and damage to the dikes, bottom, control and outlet structures, aeration equipment, and other appurtenances. In no case will pond depths be less than 6 feet (600 mm).

##### *a. Facultative Ponds*

The minimum water depth will be 6 feet (1.8 m) in primary cells. Greater depths in subsequent cells are recommended although supplemental aeration or mixing may be necessary.

##### *b. Partial-Mix & Complete-Mix Aerated Ponds*

The design water depth will be 10-15 feet (3-4.5 m). Ponds may be designed deeper depending on the aeration equipment, desired water column stratification, waste strength, and climatic conditions.

#### **130.5.1.7 Liner Thickness**

The thickness of soil/clay liners will be adjusted for the anticipated maximum wastewater depth in the pond and in no case less than 18 inches thick (constructed in 6-inch lifts). Contact the appropriate regulatory authority for liner thickness specifications.

#### **130.5.1.8 Erosion Control**

A justification and detailed discussion of the method of erosion control which encompasses all relative factors such as pond location and size, liner material, topography, prevailing winds, cost breakdown, application procedures, etc., will be provided.



*a. Seeding*

The dikes will have a covered layer of at least 4 inches (100 mm), of fertile topsoil to promote establishment of an adequate vegetative cover wherever riprap is not utilized. Adequate vegetation will be established on dikes from the outside toe to 2 feet (600 mm) inside the outside top edge. Perennial-type, low-growing grasses and/or plants that minimize erosion and are suited for the local climate are most satisfactory for seeding on dikes. In general, long-rooted crops will not be used for seeding since the roots of this type are apt to impair the water-holding efficiency of the dikes.

*b. Additional Erosion Protection*

Riprap, concrete or some other acceptable method of erosion control is required as a minimum around all piping entrances and exits. For aerated cells the design will ensure erosion protection on the slopes and bottoms in the areas where turbulence will occur. Additional erosion control may also be necessary on the exterior dike slope to protect the embankment from erosion due to severe flooding of a watercourse.

*c. Alternate Erosion Protection*

Alternate erosion control on the interior dikes slopes may be necessary for ponds, which are subject to severe wave action. In these cases riprap, concrete lining, or an acceptable equal, will be placed from one foot (300 mm) above the high water mark to two feet (610 mm) below the low water mark (measured on the vertical).

**130.5.2 Pond Bottom, Dike Cores, & Liners**

***130.5.2.1 Selection of Liner Material***

NMED recommends the use of synthetic liners as the most reliable and environmentally protective lining material currently available. Synthetic liners are suitable for a wide variety of applications. Soil/clay liners are not recommended for the following applications or conditions:



- a. fluctuating wastewater levels (e.g., evaporative ponds) or where ponds are used seasonally (e.g., storage ponds) which due to drying and/or dessication may result in compromised liner integrity.
- b. where wastewater is not chemically compatible (e.g, pH<5 or pH>10)
- c. where a facility is located in an area of concern with respect to aquifer vulnerability:
  - 1. water table aquifer (includes both unconfined and semi-confined conditions) with a vadose zone thickness of 100 feet or less, containing no soil or rock formation that will act as a barrier to saturated or unsaturated wastewater flow,
  - 2. an aquifer with known anthropogenic anoxic or nitrate contamination,
  - 3. an aquifer overlain by fractured bedrock,
  - 4. an aquifer in karst terrain,
  - 5. an aquifer with a public water supply well located within 1000 feet of the proposed pond or a gaining stream known to be impacted by nutrients from liquid waste systems.
- d. unusually high strength wastewater (e.g., total N>85, BOD>400, TSS>350)

#### **130.5.2.2      *Earth***

Earth used in constructing the pond bottom and dike cores will be relatively incompressible and tight and compacted at or up to 4% above the optimum water content to at least 90% standard proctor density – ASTM D 698.

#### **130.5.2.3      *Liners***

Ponds will be sealed such that seepage loss through the bottom and sides is as low as practicably possible. Seals consisting of soils, bentonite, or synthetic liners may be considered provided the



permeability, durability, and integrity of the proposed material can be satisfactorily demonstrated for anticipated conditions.

*a. Soil/Clay Liners*

In order for a soil to be accepted for use in a compacted soil liner, it will have: a saturated hydraulic conductivity no greater than  $1 \times 10^{-7}$  cm/sec at 90% standard proctor density - ASTM D 698,

- 1.) at least half its material passing a #200 sieve,
- 2.) a Plasticity Index of no less than 10%, and
- 3.) particles no larger than 4 mm (5/32-in).

If a soil does not meet the hydraulic conductivity it will be augmented with bentonite clay.

Samples of the liner material will be tested for standard proctor density, Atterberg limits, gradation, and characterization per Uniform Soil Classification System, and saturated hydraulic conductivity. Samples will be taken whenever the visual quality of the material changes and for every 5,000 cubic yards of visually similar material. Hydraulic conductivity tests only need to be performed on every fourth sample of visually similar material. During construction, each lift of a compacted soil liner will be field tested for density according to ASTM D 2922 and D 3017, at the rate of 5 tests per acre of bottom area or 200 feet of dike length as applicable. The liner material will be protected from desiccation or anything that will compromise its integrity during construction. Wastewater stored in a clay lined lagoon will have a pH greater than 5 and less than 10 and will contain less than 50% organic chemical content.

An independent soils/geotechnical lab will perform the tests and the results will be recorded on a NMED Compacted Test Results (CTR) form. If required, an independent lab will also determine and verify bentonite augmentation requirements. Soil description and classification will be determined using ASTM D 2487. A copy of the CTR and ASTM forms will be submitted prior to constructing the pond. Laboratory test results for hydraulic conductivity and calculations for clay augmentation recipe, if required, will include:



- 1.) the method used,
- 2.) the soil's optimum moisture content and maximum dry density,
- 3.) the bentonite's type and grade, and
- 4.) the location of the pits or borrow areas from which the materials were obtained.

b. Synthetic Liners

The liner material chosen will be chemically compatible with the wastewater, resistant to deterioration by sunlight (or covered in areas that may be exposed), and of sufficient thickness and strength to withstand wave/wind action and pedestrian maintenance activities. Synthetic liners will be at least 40 mils thick if strand reinforced, or at least 60 mils if un-reinforced (film material). Liners will be placed on a suitable foundation of sand or fine soil. Consideration will be given to slip resistance surfaces when the liner is exposed around pond edges. Liner material and foundation will be approved by a New Mexico Registered Professional Engineer and the NMED prior to installation.

**130.5.2.4 Uniformity**

The pond bottom will be as level as possible at all points. Finished elevations will not be more than 3 inches (80 mm) from the average elevation of the bottom.

**130.5.2.5 Prefilling**

Prefilling the pond will be considered in order to protect the liner, to prevent weed growth, to reduce odor, and to maintain the liner's moisture content.

**130.5.3 Inlet Works**

Multiple inlet arrangements will be used, even in small ponds. Inlet points will be as far apart as possible, and the water will preferably be introduced by means of a long diffuser designed to avoid plugging. Single inlets can be used if the inlet is located at the greatest distance possible from the outlet structure and is baffled, or the flow is otherwise directed to avoid currents and short-circuiting.



#### **130.5.3.1 Pipe Material**

Generally accepted material for underground sewer construction will be given consideration for the influent line to the pond. Unlined corrugated metal pipe will be avoided, however, due to corrosion problems. In material selection, consideration will be given to the characteristics of the wastes, exceptionally heavy external loadings, abrasion, soft foundations, and similar problems.

#### **130.5.3.2 Manhole**

A manhole will be installed prior to entrance of the influent line into the primary cell and will be located as close to the dike as topography permits. Its invert will be at least 6 inches (150 mm) above the maximum operating level of the pond and provide sufficient hydraulic head without surcharging the manhole. A vented cleanout wye may be used on small ponds.

#### **130.5.3.3 Flow Splitting**

Flow splitting structures will be designed to effectively split hydraulic and organic loads equally to primary cells.

#### **130.5.3.4 Placement**

Influent line outfalls may enter the pond along the bottom or through the sides. In situations where pipes penetrate the pond liner, provisions to prevent seepage, such as anti-seep collars or boots/sleeves, will be made.

### **130.5.4 Control & Outlet Structures and Interconnecting Piping**

#### **130.5.4.1 Control & Outlet Structures**

Where possible, facilities design will consider the use of multi-purpose control and outlet structures to facilitate normal operational functions such as drawdown and flow distribution, flow and depth measurement, sampling, pumps for recirculation, chemical additions and mixing, and minimization of the number of construction sites within the dikes.



As a minimum, control and outlet structures will be:

- (a) accessible for maintenance and adjustment of controls;
- (b) adequately ventilated for safety and to minimize corrosion;
- (c) locked to discourage vandalism;
- (d) contain controls to permit water level and flow rate control, and complete shutoff;
- (e) constructed of non-corrodible materials (metal-on-metal contact in controls will be of similar alloys to discourage electrochemical reactions); and
- (f) located to minimize short-circuiting within the cell and avoid freezing and ice damage.

Recommended devices to regulate water level are valves, slide tubes or dual slide gates. Stop logs are not to be used to regulate water levels. Regulators will be designed so that they can be preset to prevent the pond surface elevation from dropping below the desired operational level.

#### **130.5.4.2      *Piping***

All piping will be of ductile iron, reinforced concrete, or other acceptable material. Pipes will be anchored with adequate erosion control.

In situations where pipes penetrate the pond liner, provisions to prevent seepage (such as anti-seep collars) will be made.

##### ***a.      Outlet Structures***

Outlet structures, except emergency overflow channels/pipes, will be a minimum 0.3 m (1 ft) below the water surface to reduce potential impact of algae and other surface detritus on effluent quality.

Submerged Takeoffs - For ponds designed for willow or variable depth operations, submerged takeoffs are recommended.

Intakes will be located a minimum of 10 feet (3.0 m) from the toe of the dike and 2 feet (600 mm) above the pond's bottom, and will employ vertical withdrawal.



Multi-Level Takeoffs - For ponds that are designed deep enough to permit stratification of pond content, multiple takeoffs are recommended. There will be a minimum of 3 withdrawal pipes at different elevations. The bottom pipe may have a horizontal entrance or be a submerged takeoff. The others pipes will use horizontal entrances. Adequate structural support will be provided.

Surface Takeoffs - Surface overflow-type withdrawal is recommended for use under constant discharge conditions

and/or relatively willow ponds under warm weather conditions. Floating weir boxes or slide tube entrances with baffles for scum control will be evaluated during design.

Emergency Overflow - To prevent overtopping of dikes, an emergency overflow channel or pipe will be provided with capacity to carry the peak instantaneous flow expected.

*b. Hydraulic Capacity*

The hydraulic capacity for continuous discharge structures and piping will allow for a minimum of 250 percent of the design maximum day flow of the system.

The hydraulic capacity for controlled-discharge systems will permit transfer of water at a minimum rate of six inches (150 mm) of pond water depth per day at the available head.

## 130.5 NITROGEN REMOVAL

While the ability of wastewater ponds to reduce BOD and SS has been well documented, the nitrogen removal capability of ponds has received comparatively little attention. Data on the various removal pathways is insufficient for predictive relationships, between factors affecting removal and removal rates themselves, to be made. Major pathways that have been posited include: algal uptake, sorption onto settling solids, adsorption by liners and settled biosolids, nitrification/denitrification, and volatilization.

Nitrogen removal is probably best attributed to a combination of pathways, with the principal pathway (under most conditions) being volatilization. The primary factors influencing volatilization are the interface area between the water and the atmosphere, pH, temperature, and detention time. It has long been known





that ammonia can be removed by air stripping, which creates a very large interface area and is dependent on high pH. High-power aerators in ponds can enhance interface area and algal activity can elevate the pH to effective levels for brief periods. But, under normal aeration conditions and average pH levels, the rate of nitrogen removal is low.

It is prudent to assume that most all the nitrogen entering a pond system will be present in the effluent. Nitrogen in the influent may exist substantially in organic molecules, but will exist primarily as ammonia in the effluent. If nitrogen removal/conversion is required, and if a pond based system is used for secondary treatment, arrangements will be made for the addition of other unit processes to remove/convert ammonia and its subsequent products.

### 130.6 ALGAE CONTROL

Since algae constitute a major portion of the effluent suspended solids in most cases where ponds fail to perform properly, its control will be given high consideration.

#### 130.6.1 Filtration

A sand system may be used to filter algae from pond effluents, but the ability of the operating authority to maintain the system will be considered. Rock filters can be used if an acceptable cleaning procedure is developed and if an aerated water column is provided overhead.

#### 130.6.2 Hydraulic Retention Time

To minimize the growth of algae, the hydraulic retention time of each cell in a partially mixed pond will not exceed that shown in TABLE 130.3. To minimize the growth of algae, the hydraulic retention time of each cell in a settling pond will not exceed that shown in TABLE 130.3. When possible, ponds will be broken up into multiple cells to reduce the algae growth rate.

**TABLE 130.3**

No. of Cells	Detention Time (days)	
	Single Cell	Total for Settling Pond
1	2.0	2.0
2	1.6	3.3
3	1.3	4.1
4	1.1	4.6

#### 130.6.3 Mixing

Mechanical mixing will be used to prevent thermo-stratification and decrease the algae incubation whenever possible. In ponds that are not intended to



settle solids, mixing can be used to increase turbidity and reduce sunlight penetration into the water.

#### 130.6.4 Aeration

Exhausting carbon dioxide to the atmosphere, through mechanical aeration, will be considered to decrease the amount of carbon dioxide available to algae during photosynthesis.

#### 130.6.5 Cover

Any type of cover that will keep light from entering the pond will prevent the growth of algae. Floating synthetic fabric with openings for surface aerators can be used. Duckweed and other floating aquatic plants can provide a natural cover. If floating aquatic plants are used, harvesting is not required but floating grids will be supplied to control dispersion.

### 130.7 BIOSOLIDS STABILIZATION

Biosolids stabilization rates will be maximized to protect the public and to minimize handling and disposal costs. Providing both proper surface area and aeration rates increases stabilization rates. Because biosolids stabilization in ponds results from a combination of aerobic and anaerobic activity, dissolved oxygen in the water column (above the biosolids blanket) will be maintained at 2 mg/L. If the oxygen concentration drops below 2 mg/L, the consistency of the aerobic processes decreases, and the stability of the biosolids blanket is damaged. A non-stable biosolids blanket can generate odorous gasses that escape to the atmosphere.

#### **EQUATION 130.4**

$$B_{oxy} = 30(1.07)^{T_s-20}$$

#### **EQUATION 130.5**

$$B_{an} = 50(1.39)^{T_s-20}$$

$T_s$  = temperature of the biosolids blanket (°C)

$B_{oxy}$  = aerobic stabilization rate (g/m<sup>2</sup>-d)

$B_{an}$  = anaerobic stabilization rate (g/m<sup>2</sup>-d)

Biosolids stabilization rates will be determined from observing the biosolids blanket loading and buildup over time at adjacent or nearby facilities. If vicinity ponds are not available, stabilization rates can be determined using pond water temperatures and EQUATIONS 130.4 and 130.5. If records are not available, EQUATION 130.3 can approximate the pond water temperature. Biosolids temperatures will be estimated at 2°C less than the equilibrium temperature, unless measured data is available. Aerobic stabilization rates will not exceed



60 g/m<sup>2</sup>-d. Anaerobic rates will not exceed 150 g/m<sup>2</sup>-d. The unit rate of benthic oxygen demand may be assumed to be 80 g/m<sup>2</sup>-d.

## **130.8 MISCELLANEOUS**

### **130.8.1 Fencing**

The pond area will be enclosed with an adequate fence (chain-linked or woven fencing) to prevent access by children or dogs and discourage trespassing. Fencing will not obstruct maintenance vehicle traffic on top of the dikes. A

vehicle access gate of sufficient width to accommodate mowing equipment will be provided. All access gates will be provided with locks.

### **130.8.2 Access**

An all-weather access road will be provided to the pond site to allow year-round maintenance of the facility.

### **130.8.3 Warning Signs**

Appropriate permanent signs will be provided along the fence around the pond to designate the nature of the facility and advise against trespassing. At least one sign will be provided on each side of the site and one for every 500 feet (150m) of its perimeter.

### **130.8.4 Flow Measurement**

Flow measurement requirements are presented in Chapter 50, paragraph 56.6. Effective weather protection will be provided for the recording equipment.

### **130.8.5 Ground Water Monitoring**

An approved system of wells will be required around the perimeter of the pond site to facilitate ground water monitoring. The layout and sampling requirements for such monitoring will be determined by the NMED.

### **130.8.6 Pond Level Gauges**

Pond level gauges will be provided.



### **130.8.7 Service Building**

A service building for laboratory and maintenance equipment will be provided if required. Refer to Chapter 50, Section 58.